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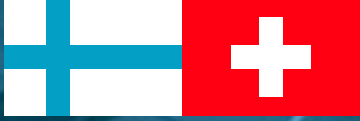
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THE FINNISH SYSTEM OF INNOVATION – LESSONS FOR SWITZERLAND?

SATW

Schweizerische Akademie der Technischen Wissenschaften
Académie suisse des sciences techniques
Accademia svizzera delle scienze tecniche
Swiss Academy of Engineering Sciences

$$C(s) = \frac{C(s)}{M(s)} = \frac{1}{T}$$

SATW

The Swiss Academy of Engineering Sciences, SATW, is one of four academies recognised by the Swiss government as institutions promoting research. Its purpose is to promote the engineering sciences and their application in order to serve Switzerland as a place of education, research, development and production and, hence, the general public, economy and culture of Switzerland.

The SATW is an apolitical non-profit organization with approx. 200 individual members. As an umbrella organization for some 60 member institutions and societies in the field of engineering sciences, it represents the interests of some 60,000 technology-oriented members.

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Preface

Innovation has become a key element of the economic growth of highly developed countries. Moreover, it is an undisputed fact that Switzerland needs to strengthen its efforts at innovation. This has become clear, among other things in the message of the Federal Council, the Swiss government, which emphasises the promotion of education, research and technology for the years 2004 to 2007. Speedy implementation of technological and scientific potentials into innovative products and services is one of the primordial requirements to be competitive in the marketplace and, hence, to secure jobs. Primarily, this is a challenge to entrepreneurs. It is more demanding to launch into activities with innovative products and services, and greater risks are involved, than in the rationalisation of existing productions. Nevertheless, although entrepreneurial skills and qualities are at the fore with regard to successful innovative processes, the influence of the state with its framework should not be overlooked. It is well worth examining and reconsidering these factors from time to time. Comparing the Swiss innovation system with those of other countries can be a highly profitable exercise.

One of the most important concerns of the Swiss Academy of Engineering Sciences, SATW, is the promotion and valorisation of knowledge. The network of experts, member societies and sister academies abroad is an ideal instrument for the comparison of the Swiss innovation system — not unlike production processes — with those of other countries in order to understand where there might be room for improvement at home. This is why the SATW commissioned the team of authors with Adrian Berwert, Barbara Good and Andreas Reuter-Hofer, under the leadership of Prof. Dr. Beat Hotz-Hart, to study the Finnish innovation system with the purpose of making recommendations for Switzerland. The study was accompanied by a monitoring group from the SATW which consisted of Ms. V. Boban and Messrs. Dr. F. Caccia, Prof. Dr. R. Dändliker, Dr. H. Hänni, Prof. Dr. H. Leuenberger, Dr. J. Randegger, W. Roos and Dr. M. Roulet.

For their support and commitment the SATW owes a debt of gratitude to the team of authors, the Finnish and Swiss interview partners, the Finnish Academy of Technology, the Ambassador of Finland in Switzerland, the Ambassador of Switzerland in Finland, the Commission for Technology and Innovation, CTI, the sponsors, and the members of the SATW Monitoring Group.

The SATW is certain that the implementation of the recommendations made in this report will result in progress in the Swiss innovation system, and a productive increase in innovative activities.

January 17, 2004 Willi Roos, President SATW

Abbreviations

CHF	Swiss Franc		search of the Fraunhofer Society
CSCE	Conference for Security and Cooperation in Europe	KIBS	Knowledge-intensive Business Services
CTI	Commission for Technology and Innovation	KTT	Knowledge and Technology Transfer
DEA	Federal Department of Economic Affairs	NCCR	National Centres of Competence in Research
DHA	Federal Department of Home Affairs	NIS	National Innovation System
EC	European Communities	OECD	Organization for Economic Co-operation and Development
EFTA	European Free Trade Association	ORC	Optoelectronic Research Centre, Tampere Technical University
EMU	Economic and Monetary Union	PISA	Programme for International Student Assessment
EU	European Union	R&D	Research and Development
EU-15	The 15 EU Member States: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, The Netherlands, Portugal, Sweden, Spain, The United Kingdom	SATW	Swiss Academy of Engineering Sciences
FDF	Swiss Federal Department of Finance	Sitra	The Finnish National Fund for Research and Development
GDP	Gross Domestic Product	SME	Small and Medium-Sized Enterprises
GSM	Global System for Mobile Communication	SNF	Swiss National Science Foundation
ICT	Information and Communication Technology	Tekes	National Technology Agency of Finland
ISI	Institute for Systems and Innovation Research	US\$	US-Dollar
		VTT	Technical Research Centre of Finland

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1. Introduction

Since the 1990s Finland has shown impressive economic results that have met with great interest abroad. Finland has been able to dissociate itself from its strong economic dependence upon natural resources, reorienting itself in a new politico-economic context. This has resulted in significant increases in growth rates, high-tech exports and national wealth. In international comparisons, Finland's economy steadily emerges as innovative and highly competitive; it regularly tops the rankings.

Economic dynamics in Finland are driven by innovative firms. However, contrary to received wisdom, it is not only the Finnish mobile telephone giant, Nokia, and the ICT cluster that are responsible for the Finnish success story, a fact which is all too often overlooked. Other branches such as the wood-processing industry, opto-electronics and other technologies are of similar significance to the development of the Finnish economy. Upon closer inspection, moreover, the successes of the Finnish industry have been promoted by early and intelligent decisions in innovation policy, a policy that encourages the production, dissemination and application of knowledge for the development of new products, production processes and forms of entrepreneurial organisation. In this context it is policies concerning education, research and technology that are key. There is no doubt that these policies have had a significant impact upon Finland's innovative and competitive success.

In view of the fact that Switzerland has been suffering weak economic growth for over a decade, and of the on-going discussion of adequate political instruments to overcome this weakness, the Swiss Academy of Engineering Sciences (SATW) initiated the

present study. The SATW's chief concern has been to find out what lessons Swiss policy makers can draw from the Finnish success story.

The focus of this study therefore lies on Finland's innovation policies and innovation-based successes. The most important actors are presented, as well as institutional structures of Finnish innovation policy. Also, an overview of instruments for innovation policy are presented.

Comparing countries can be problematic. The histories and economies of Finland and Switzerland developed in different ways; their institutional structures are different. One of the greatest differences between the two countries is their political and economic situations. Political measures cannot, therefore, be adopted or copied without adaptation. Finnish developments and the structures of the Finnish innovation system have therefore been analysed bearing in mind the difficulties involved, as well as the specific situation of Switzerland. Hence, the political recommendations made in this report are suited to the political context and framework of Switzerland.

It is true that many aspects of Swiss economic and innovation-related performance are still excellent — even better than in Finland. However, international studies have shown that Switzerland has been losing ground. Great efforts are therefore required to strengthen the innovative capabilities and competitiveness of Switzerland if this country is to retain — or regain — its place at the cutting edge.

One of the bases of this study is a synthesis of existing literature. Of equal, if not greater relevance

are interviews by the authors with exponents of the Finnish innovation system, conducted in Finland in August 2003, followed up in October 2003 by a video conference with our Finnish partners to evaluate and complement insights gained until that point in time. The study was monitored by the SATW, which organised a workshop to discuss our insights and recommendations for Switzerland. We greatly appreciate the valuable information and input provided by our interview partners in Finland, and the SATW monitoring group.

Chapter 2 provides a brief outline of Finnish history and the economic development of Finland. This background is essential to understand the success that Finland is currently enjoying. Chapter 2 also contains an overview of the most important actors in the Finnish innovation system. Chapter 3 reports on selected areas of the Finnish innovation system, while chapter 4 presents key ideas forming the backdrop to seven recommendations for the Swiss innovation system. Chapter 4 can also be read as a summary of our study.

2. Framework Conditions and Developments

2.1. Finland — an Overview

Finland is a parliamentary republic with a strong presidential element. The President is elected for a term of six years. The President and the government share the highest executive powers. The new constitution of the year 2000 has strengthened the Finnish parliament, which now elects the Prime Min-

ister, while the other ministers are appointed by the President upon the Prime Minister's recommendation. Also in 2000, Finland's first woman President was elected, the Social Democrat and former Foreign Minister, Tarja Halonen.

Sociodemographics: Comparison between Finland and Switzerland

	<i>Finland</i>	<i>Switzerland</i>
Surface in sqkm	338,000	41,280
Population in thousands, 2002	5,207	7,318
Population density	16 pers./sqkm	177 pers./sqkm
Population growth, annual average in %, 1990-2002	0.4%	0.6%
Age structure, 2002	0-14 yrs.: 17.8% 15-64 yrs.: 66.9% > 65 yrs.: 15.3%	0-14 yrs.: 15.9% 15-64 yrs.: 68.6% > 65 yrs.: 15.5%
Proportion of foreigners, 2002	2.0%	20.3%
Proportion of persons with a tertiary education (aged 25-64 yrs, 2002)	32.4%	25.3
Main languages, in %, 2000	Finnish: 92.4% Swedish: 5.6% Other: 2.0%	German: 63.7% French: 20.4% Italian: 6.5% Other: 9.4%

Sources: Swiss Federal Statistical Office: www.statistik.admin.ch; Statistics Finland: www.stat.fi; Cordis, EU Innovations Scoreboard 2003: trendchart.cordis.lu/scoreboard2003/html/indicators/indicators_1.2.html, according to EUROSTAT.

The government requires the confidence of the unicameral parliament's 200 MPs, who are elected by the voters every four years. The 2003 parliamentary elections resulted in the following distribution of

seats: Centre Party of Finland: 55 seats; Social Democratic Party: 53; National Coalition Party: 40; People's Democratic League/Left Alliance: 19; Green League: 14; Swedish People's Party in Fin-

land: 8; Christian League of Finland/Christian Democrats in Finland: 7; Rural Party/True Finns: 3; other: 1. The newly-formed coalition government (Centre Party, Social Democratic Party, Swedish People's Party) is headed by the Speaker, Matti Vanhanen (Centre Party).

Finland consists of six *provinces* governed by the Finnish state, and some 450 *communities* with autonomous local governments whose position was strengthened by the reform of 1995. The communities are funded by community taxes and financial transfers from the central government. Approximately two thirds of public services are currently provided by the communities (specifically education, social and health services).

Large parts of Finland are very sparsely populated. The majority of the Finnish population of approx. 5.2 m inhabitants lives in the south in and around the main cities of Helsinki, Espoo, Turku, Vantaa and Tampere. An important economic regional centre in the north is Oulu. Just under two thirds of the Finnish population now live in cities.

Population growth is comparatively low, not least because of low immigration. *Foreigners* make up a *remarkably small part* (2%) of the population. Of greater significance is domestic migration from rural areas to economic centres.

Like all Scandinavian countries, Finland has a highly developed *welfare system*. Cultural and social differences are less significant than in other countries. There are few if any social hierarchies in Finland; the predominant communicative culture is very open and the social climate is quite positive. This is confirmed by the comparative absence of corruption, low crime, and the trust enjoyed by public authorities and institutions. Moreover, Finland has a well-endowed, high-quality *educational sys-*

tem. Approximately 32% of the inhabitants have a tertiary degree — greatly above international average.

2.2. Finland's Historic Position between 'East and West'

2.2.1. Traditional ties to the neighbouring countries, Sweden and Russia

The history of Finland has been deeply influenced by close ties to the two neighbouring countries, Sweden and Russia. Until very recently they affected Finnish politics, society and economy.

For a long time life in Finland and its development were influenced by armed conflicts with Sweden, the old mother country whose rule and influence lasted six hundred years. This long period has left its mark on Finnish religious life, the law, education and public administration — the roots of the Finnish state. These close ties with Sweden notwithstanding, the cultural influence of France and, after the Reformation, of the German Lutheran universities was also significant. Finland reached its first economic and cultural peak in the 17th century, which is when the first university was founded in Turku (1640). Sweden's influence decreased after 1809 and Finland became an autonomous, relatively independent Grand Duchy of the Russian Empire with its own Senate. However, its code of laws still dated back to the Swedish era. The Russian influence on Finnish politics, culture and economy always remained fairly insignificant. Helsinki became the Finnish capital in 1812.

Finland's road to independence

Finnish nationalism gained momentum during the first half of the 19th century. It was directed against

Russia, and Swedish cultural hegemony. The Finnish and Swedish languages were declared equal in 1863. The Bank of Finland was founded as early as 1811 — earlier than the central banks of most today's industrialised countries. The Finnish Mint was established in 1878. Communications and transport networks (telegraph, railway) expanded rapidly.

The *Russification policy* of tsar Alexander III curtailed Finnish autonomy. However, the unicameral system was introduced through a parliamentary reform following the Russian Revolution of 1905, including universal suffrage for both men and women. After the February Revolution of 1917, in which the Russian tsar was deposed, the Finnish state parliament took power, declaring Finnish independence on December 6, 1917. A time of internal strife followed. The years after 1930, however, brought a period of economic growth, largely driven by the developing wood and paper industries. From 1870 until 1939 Germany played a significant role in Finland's economic and cultural relations.

Difficult relations with the Soviet Union

Finnish foreign politics were governed by the need to maintain good neighbourly and largely conflict-free relations to the Soviet Union, regardless of the so-called Winter War during World War II. The Treaty of Friendship, Cooperation and Mutual Assistance concluded in 1948 was confirmed one last time in 1983. Nonetheless, Finland also cautiously expanded its relationships with the other Scandinavian and Western European countries (EFTA). During the second half of his presidency, U.K. Kekkonen (1956-1981) actively pursued a policy of neutrality between the then-existing two blocks. He aimed to preserve Finnish sovereignty despite Finland's dependence on the Soviet Union. So-called *Finlandisation* became a political by-word, used positively to describe the Finnish brand of neutrality,

and negatively to describe Finland's vacillation between the super powers while being politically dependent on the neighbouring giant. It was in that era that Finland initiated the geopolitically crucial Conference on Security and Cooperation in Europe (CSCE), held in Helsinki in summer 1975. Due to its complex relations with the Soviet Union, Finland only became a full member of EFTA in 1986, and only acceded to the Council of Europe in 1989. Nevertheless, after World War II, the country vastly expanded its economic and cultural relations to the West, in particular to Great Britain and the U.S.

Finland's more open foreign policy

The disintegration of the former Soviet Union and increased integration of the European Community significantly affected Finland's geopolitical and economic situation. Boundaries that had previously seemed to be unwavering were suddenly shifting. Finland was no longer a victim of the Cold War. Although a new treaty on good relations between Russia and Finland was concluded in January 1992, this did not prevent Finland from conducting a more open foreign policy. Following the partial loss of economic relations with the member countries of the former Soviet Union, the Finnish economy was facing *new challenges*. In March 1992 Finland officially applied for membership to what was then the EC. Since 1995 it has been a full member of the European Union (EU) and, since 1999, a member of the European Economic and Monetary Union (EMU).

2.2.2. Finland's economic development

Forest economy drives Finland's late industrialisation

Industrialisation and division of labour came fairly late to Finland which, in the middle of the 19th century, was still among the poorest countries in Europe.

In particular it was industrial production and exports of the rapidly growing *wood industry* — alongside the textile and metal industries — providing a massive economic boost to Finland and creating some prosperity. A *key innovation* in the Finnish economy was the production of paper from wood pulp. The first paper mill went into operation in 1880. For quite some time Finland was in the technological lead over Russia in paper and cellulose industries. Early prosperity in Finland was therefore based largely on the production and export of wood and paper.

The so-called forest economy of the 20th century provided the foundation for remarkable economic growth rates and a virtually unparalleled process of economic recovery, at the cost of significant dependence on natural resources (wood). The forest economy initiated and promoted the development of a whole range of other sectors of economic activity, as well as related chains of added value and innovation (i.e., electricity, waterways for transport, machine industry for forestry and paper production, chemical industry, electronic industry, consulting, etc.). The dependence on natural resources was gradually reduced. The massive expansion of the metal and mechanical industries also dates back to the years after World War II. For quite some time Finland's economy relied on the *production of items of capital expenditure*. As late as the 1980s it was believed that Finland would be unsuccessful in the world markets for consumer goods. The more recent economic history of Finland and the triumphant success of Nokia mobile telephones were to prove those voices wrong.

The 1960s and 1970s — a period of rapid economic recovery

To catch up with technological progress elsewhere and to reduce dependence on Finland's natural resources, the export-dependent industries — heavy

industry, cellulose and paper industry, metal and mechanical industries, chemical industry — invested more heavily in new technologies than the international average. Their *investment and industrialisation strategies*, and the creation of engineering and technological know-how provided a further milestone on Finland's road to a highly competitive economy in the international context, an economy whose technology-intensive exports produce high added value.

This period of modernisation also saw the *creation of the Finnish welfare state*, including an expanding public sector and social state system (Scandinavian welfare model), high investments in a regionally balanced university system, and a rapid growth of urban centres in the south of Finland.

The 1980s — structural change and tertiarisation

It was in the early 1980s that Finland witnessed a fundamental structural change from an industrial to a service economy (tertiarisation), which came fairly late but was all the more intense. Large numbers of new, service-oriented workplaces were created in the state administration, while employment in the industrial sector shrank by 20%, and dropped by 40% in the primary sector (agriculture, forestry, fisheries). The period leading up to the late 1980s was one of rapid economic growth, a remarkable increase in productivity, and rapidly *growing wealth*. By the end of the 1980s Finland was among the wealthiest industrialised countries.

Sharp recession in the early 1990s

The Finnish economy took a plunge in the early 1990s, falling into a sharp recession caused by too expansive a macro-economic policy, a crisis in the banking system, recessive trends in the industrial countries, and the collapse of markets in and trade

with member countries of the former Soviet Union. From 1991 to 1993 production and gross domestic product (GDP) shrank by approximately 10% while *unemployment* rocketed from less than 3% in the late 1980s to a record-breaking 20%. Prior to this recession per-capita GDP had been about 5% above that of the EU-15 countries; afterwards it was 13% below. Tertiariisation had come to a dramatic standstill.

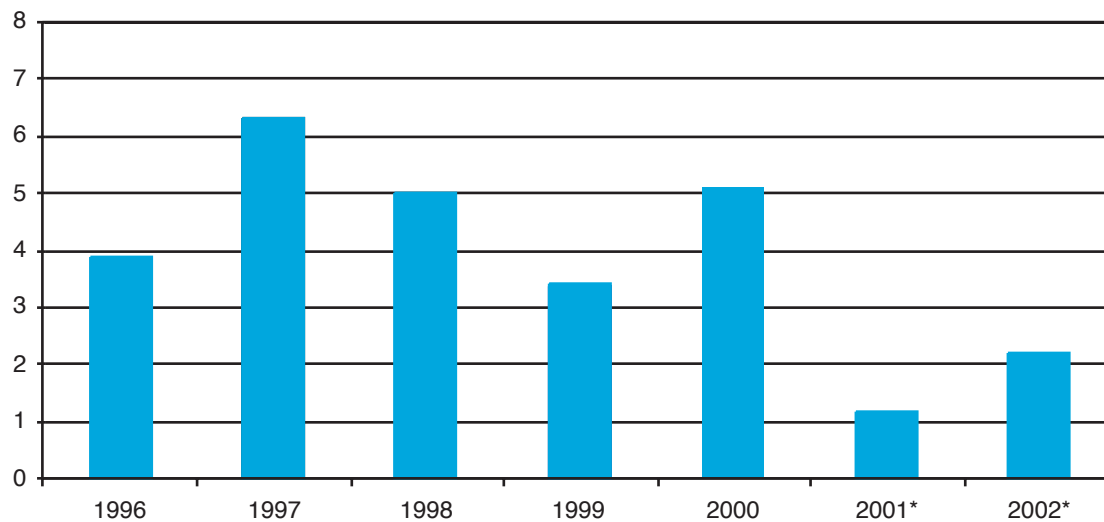
Institutional changes and strategic plans for an innovation policy made and conceived in the 1980s provided the basis from which *Finland bounced back*. Although the recession had been deep and painful, a positive outcome was that it released Finland from a long-term economically negative dependence on an imbalanced sectoral structure. The economic crisis was a kind of „cleansing process,“ *removing impediments to further economic and institutional reforms*. This is not to say that changes were initi-

ated by the recession itself. But it did accelerate the on-going restructuring processes, contributing to the adoption of new concepts of economic policy (see also Chapter 2.3).

Return to the road of economic expansion

Driven by Finnish exports and a massive increase in productivity, the Finnish economy has made an impressive recovery since the deep recession of the 1990s. Except in 2001 (see table below) GNP always increased by more than 3% from 1994 to 2000, exceeding average growth in other EU countries. A comparison of the per-capita GDPs of Finland and its former mother country, Sweden, also places Finland in a favourable light. Critical voices, however, have been warning about *one-sided dependence on (exports in) telecommunications*, where the world market leader, Nokia, is responsible for a significant proportion of economic growth.

Annual Growth of Finnish Gross Domestic Product (GDP), 1996-2002, in %



Source: Statistics Finland

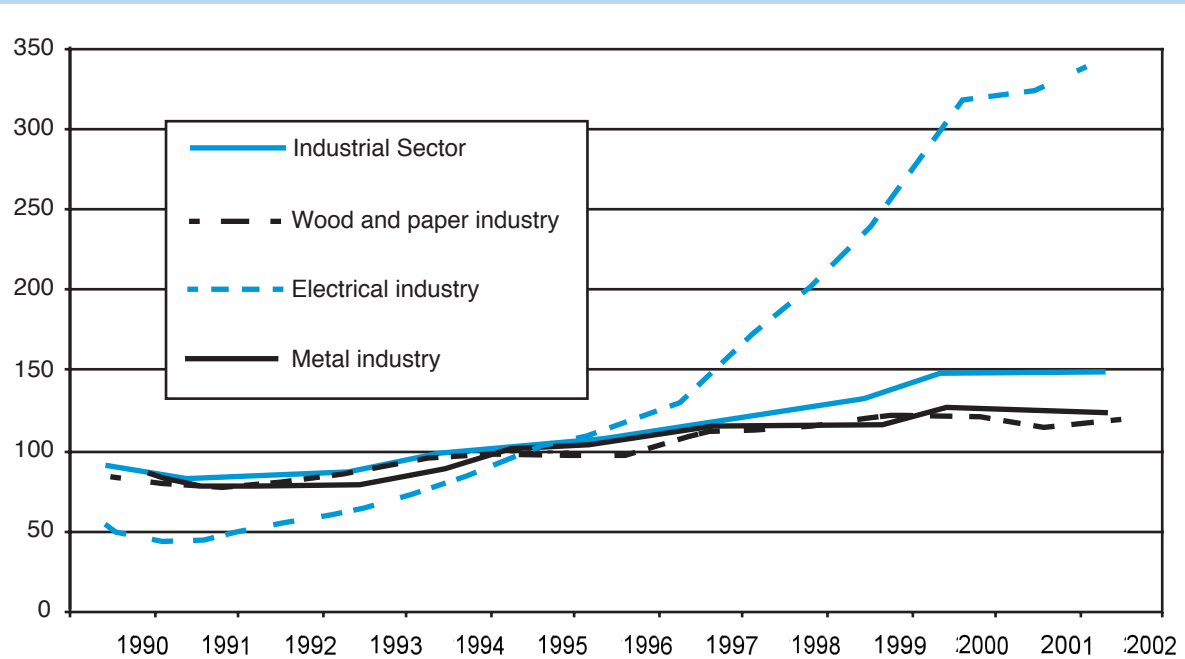
*provisional figures

There is no doubt that some of the above-international-average economic growth is due to a *process of recovery* following the recession. Finland's accession to the EU and to the EMU, and hence free access to Europe's domestic markets, has also played a significant role. An OECD study has found that since it *joined the EU* in 1995 Finland has been the country that benefited most from its membership, estimating annual growth at approximately 0.8%.

Unlike other industrialised countries, the growth of Finland's *industrial sector* has not been affected. On the contrary: a significant proportion of the growth is still due to industrial production. From 1995 to 2002

total industrial production has increased by 44%, largely due to the very rapidly expanding electronics and telecommunications industry (Nokia, +250%). It has been estimated that for 2000, Nokia's contribution to general economic growth is 30%. However, the wood and paper industries as well as the metal industry have also made a significant contribution (+20%; see table below).

The 1990s brought significant structural changes to Finland, as well as a shift in specialisation towards the *knowledge-intensive high-tech sector*. Again, the entire ICT cluster, Nokia and their various suppliers played a key role.

Annual Growth of Finnish Industrial Production, 1990-2002, indexed (1995 = 100)

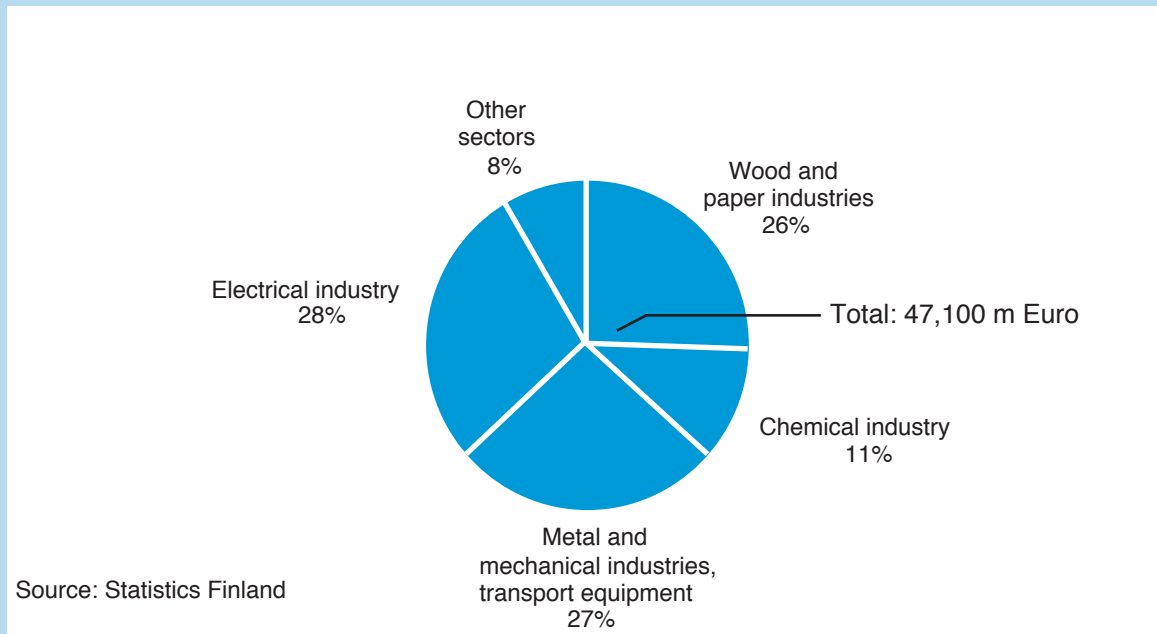
Source: Statistics Finland

Finland's economic structure

The economies of both Finland and Switzerland are small and open, relying greatly on exports. Exports account for approximately one third of the Finnish GDP, of which 54% go to the EU. The most important countries importing Finnish goods are Germany (2002: 11.8%), Great Britain (9.6%), the U.S. (8.9%), Sweden (8.5%) and Russia (6.6%). In recent times there has again been a significant increase in trade with Russia.

There is a certain dependence on Nokia's export success: exports of electronic and electrical products, most of which are manufactured by Nokia, make up for 28% of total Finnish exports. However, exports in other industrial sectors, i.e. the transport equipment and metal and mechanical industries (27%), as well as the wood and paper industries (26%), are of almost equal importance to Finland (see table below).

Volume Index of Finnish Exports, by Industrial Branch, 2002, in %



Since the mid-1990s Finnish exports have increased by an average of 8% annually — significantly more than imports. The *balance of trade surplus* has therefore also increased sharply and, in conjunction with favourable developments in terms of trade (relationship of export and import prices), has made an important contribution to increasing Finnish wealth. The *favourable terms of trade* are chiefly due to the fact that almost twice as many high-tech products are exported than imported. High-tech products account for approximately one fifth of all exports, 17% of which are telecommunication products.

Agriculture and forestry now employ fewer than 6% of the *Finnish workforce*, while the industrial sector still employs 27%. These numbers illustrate the fact

that Finland is well on the road to a service economy. Electronics and telecommunications (most importantly, Nokia) account for approximately one quarter of the added value in the industrial sector. In 2001 Nokia alone contributed 2.8% of the GDP. Other significant contributors to added value created in Finland are the wood-pulp and paper industries (14%), the metal and mechanical industries (10%), and the chemical industry (9%). The contribution of the wood-processing industry (3.5%) is significantly lower although it employs more than 6% of all industrial workers. 15% of the workforce are employed in trade; financial services, insurances and other business consulting services account for 12%.

At 27% the proportion of employees in the public sector is relatively high. In some peripheral provinces the public sector is even the most important employer.

Innovative and knowledge-intensive business services — KIBS — play a crucial role in the creation and diffusion of innovations. As suppliers of knowl-

edge-intensive services to private firms, they are typically SMEs (i.e. business consultants, providers of technical services, private research, design, etc.). Studies have shown that the potential of KIBS might still be made better use of by improved integration into the Finnish innovation system.

Some Basic Economic Figures: a Comparison of Finland, Switzerland and the EU

	<i>Finland</i>	<i>Switzerland</i>	<i>EU</i>
<i>GDP per capita:</i> adjusted purchasing power, in US-\$, 2001	26,097	31,005	24,320
<i>Annual growth in GDP, real average growth, in %:</i> 1995-2001 2002	4.3 2.2	1.7 0.2	2.4
<i>Employees by sector, in %, 2001</i>	1st sector: 5.8 2nd sector: 27.1 3rd sector: 67.1	1st sector: 4.2 2nd sector: 24.7 3rd sector: 71.0	1st sector: 4.4 2nd sector: 28.6 3rd sector: 67.2
<i>Unemployment:</i> 2001 2002	10.3 10.1	2.6 3.2	7.6
<i>Exports per inhabitant:</i> Export of goods and services, in US-\$, 2001	8,238	11,353	6,063
<i>Public debt, in % of GDP, 2001</i>	43.6	49.6	69.1
<i>State quota (state expenditures incl. compulsory social insurance, in % of GDP):</i> 1990 1995 2001	44.4 54.3 44.3	33.1 38.4 38.6	

Sources: Federal Office of Statistics: www.statistik.admin.ch; Federal Finance Administration: calculation of the state quota; Statistics Finland: www.stat.fi; ETLA, Research Institute of the Finnish Economy: www.etla.fi

Despite soaring economic growth, *unemployment* has remained one of Finland's urgent problems. Although joblessness has been halved to 10% since its peak in 1994, *young people* are still facing an extremely *high unemployment rate* of over 20%.

While the Finnish *state quota* is very high compared with most other countries, it is still far below that of its two Scandinavian neighbours, Sweden and Denmark. Owing to a positive economic situation, public debt has decreased since the second half of the 1990s.

Internationalising the economy

The internationalisation of the Finnish economy started later than in most other industrialised countries, but it has progressed all the more rapidly since the 1980s. Finland's late internationalisation is due not least to *Finnish economic nationalism*, which for a long time impeded foreign investment, and the importation of foreign technology. With regard to industrial, technological and economic developments, Finland relied on the development of its own resources for too long, pursuing a very different strategy than Ireland, for example, whose economy relies largely on foreign investment capital and imported technologies.

Rapid internationalisation has had a deep impact on the structure of the Finnish economy. *Direct investments* by Finnish firms, and the number of employees of Finnish companies abroad have multiplied. Foreign companies increasingly began to invest in Finland when property restrictions for foreigners were dropped in 1993, and after Finnish accession to the EU in 1995. The 1990s saw a rapid increase of foreign-owned companies in the industrial and service sectors.

By the late 1990s 150 of the 500 largest Finnish companies were foreign-owned. Today the biggest foreign-owned company is ABB Finland, one of the most important employers. A strong motivation for foreign participation and takeovers is access to Finnish know-how and Finnish technology. This is particularly true in the ICT sector. However, Finnish investments abroad are still approximately twice as high as foreign investments in Finland.

2.3. Innovation Policy Sets the Course for Finnish Success

Current international benchmark studies and country rankings show that Finland is top of the list of innovative and technologically advanced, dynamic and highly competitive economies. Moreover, Finland is considered one of the most advanced countries with regard to the development of a modern, *knowledge-based and technology-intensive economy and society*.

The severe recession and high unemployment of the early 1990s came as a shock to Finnish society, compelling the private sector and political decision-makers to change course. Firms actively participated in the creation of dynamic innovation networks. One of the most important examples is the ICT cluster, in particular the technological and economic success of Nokia and its approximately 200 supplier firms. Nokia's economic success is due to massive R&D efforts as well as consistent technological specialisation and market orientation alongside Nokia's technological lead in the GSM standard. With some government support, Nokia also conducts intense networking with supplier firms, academic partners and other research institutions. Another key to Nokia's success is Finland's technological leadership in ICT infrastructure (Inter-

net), early liberalisation and competition in ICT, as well as the Finnish population which has readily embraced new technologies.

Moreover, strategic decisions in education, research and technology policies and economic developments in Finland have complemented each other. A good example is the recent increase in engineering and science graduates. Without adequate increase in human resources the rapid growth of public R&D expenditures would only have driven up salaries. However, the number of engineers and technicians was able to keep up with the rising R&D expenditures because the Finnish state had invested in the expansion of tertiary education. The technological upgrading of Finnish firms, Nokia in particular, benefited greatly from a highly qualified workforce available in greater numbers, as well as state-funded R&D. Finland's success is due not only to the success of individual firms, but can be explained by the successful reaction of state measures to entrepreneurial requirements.

While Finland's economic upswing and its transformation into a highly technological and innovative economy have been driven by the private sector, the decisions regarding a state policy that supports innovative enterprises nevertheless deserve our attention.

Political consensus

Historical developments in Finland and its geographically marginal location have enhanced Finnish awareness that a prospering economy and social developments can only be achieved if there is consensus on the greater goals. Since World War II the Finns have managed to rise to various economic challenges and to push for reorientation and modernisation at various stages. Finnish willingness to embrace technological change has always been a

particular asset.

One essential source of the current success of the Finnish economy has been the *explicit consensus* at a political level that knowledge is key to economic developments. Earlier than any other European country Finland declared *knowledge-intensity and technological superiority* to be strategic policy objectives. Strengthening Finnish innovation achievements has become the common goal of the private sector, science, politics and public administration. It is only logical that issues such as education, research and innovation should have become the concern of top-level politicians. Regardless of the coalition in power, this has led to a consistent Finnish research, technology and innovation policy.

Moreover, this awareness of the relevance of an innovation policy has been accompanied by the government's highly solution-oriented, pragmatic attitude, reflected in a close and fruitful cooperation between the private and political sectors as well as the universities.

New priorities and long-term approach to innovation policy

To speed up institutional change and restructuring processes, a *new concept for innovation policy* was introduced in the early 1990s. It has found the support of all the relevant players in Finnish politics, the private sector and society, and has gradually been implemented. Finland was the first OECD member country to use the concept of a „*National innovation system*“ to formulate and implement an education, technology and innovation policy. Finnish decision-makers in the public administration and in the private sector have agreed on what drives innovation and on the political potential of innovation promotion.

In an innovation system innovations emerge from the interplay of organisations that produce and disseminate knowledge and skills. From this perspective innovations in a society not only depend on individual organisations such as firms, universities and research institutes; what matters is the *interplay of the various actors* in the system. Even though private firms remain the most important actors in the innovation system — as developers and launchers of innovations — educational and research institutions also play an important role.

As early as 1978, the Finnish Technology Committee coined the term „information society.“ Moreover, from the mid-1990s onwards, Finland adopted the concept of a „*knowledge-based society*“ in its political discourse, and proceeded to increase investments in education, research and technology. This intensified the structural shift to technology-intensive sectors of the economy, in particular information technology.

Among other things, the conceptual reorientation of Finnish innovation policy is related to the fact that Finland has been a very active participant in international organisations discussing new concepts in economic and innovation policy, and has benefited from experiences made by other countries with new political strategies (benchmarking). *The Science & Technology Policy Council* assumed a crucial role in the introduction of these concepts and the setting of new priorities in Finnish innovation policy.

The formulation of a political strategy based on the concept of an innovation system occurred in roughly two stages: the initial stage (1980s) was concerned with *the establishment of important institutions and organisations* in the field of innovation policy. Important waystages towards better-integrated and coordinated science and technology policy were the establishment in 1983 of Tekes as the heart of Finn-

ish technology policy (see also Chapter 3.2.2), and the creation of the Science & Technology Policy Council in 1987 (see also Chapter 2.4).

By the 1990s, however, the focus had shifted more towards issues of *networking* and interplay in the innovation system. In particular this strategy aimed to strengthen applied research, both financially and otherwise. Political interest became focused on the interplay of the private sector, universities and research institutions.

The Finnish government has given its *innovation policy very high priority*. Innovation policy is considered a promising strategy for the government to actively shape economic and social developments. The high priority is reflected not only by funding allotted to innovation policy, but also by the extent of coordination with other political areas.

Farewell to industrial policy

At the same time Finland has also shifted away from traditional industrial policies, replacing state intervention by sound *economic framework conditions*. The focus has been on new policies regarding competition, privatisation, and market liberalisation.

Based on the insight that it is possible to enhance the innovative capacity of an economy by contributions from various other political areas, such as regional and labour market policies, coordination between these areas has been stepped up.

High investments in research & development

Crucial decisions were taken in Finland in the early 1980s. Key players in the private sector realised that Finland's successful economic development could no longer rely on raw materials and on the Eastern European markets. Finland's comparative edge was

to be based on knowledge intensity and technological superiority rather than simple cost efficiency. Accordingly, immaterial investments in the field of knowledge and education increased, and the *structure of the Finnish economy shifted towards knowledge intensity*. Formerly rather modest private sector R&D expenditures therefore saw a steady growth.

These developments in the private sector were accompanied by various initiatives in the public sector. *National technology programmes* — large, network-based R&D programmes — were introduced in the early 1980s. Tekes was established in 1983 for the planning and implementation of these technology programmes, and for the public support of private sector R&D. Even during the great recession and in a period with a higher state deficit, Finnish public R&D expenditures continued to increase as a deliberate strategy in contrast with other industrialised countries, where public R&D spending stagnated or even decreased.

In 1996 the Finnish government decided to increase public R&D expenditures by 25%, and to increase the R&D percentage of GDP to 2.9% by 1999 (see table below). These efforts were funded by the privatisation of state-owned enterprises. The decision was based on the assumption that increased R&D activities would provide a crucial boost to the innovation system, the economy's innovative capacity, and economic growth.

The increase of public R&D spending authorised by the Finnish government has been unable to keep up with private R&D expenditures. Public R&D expen-

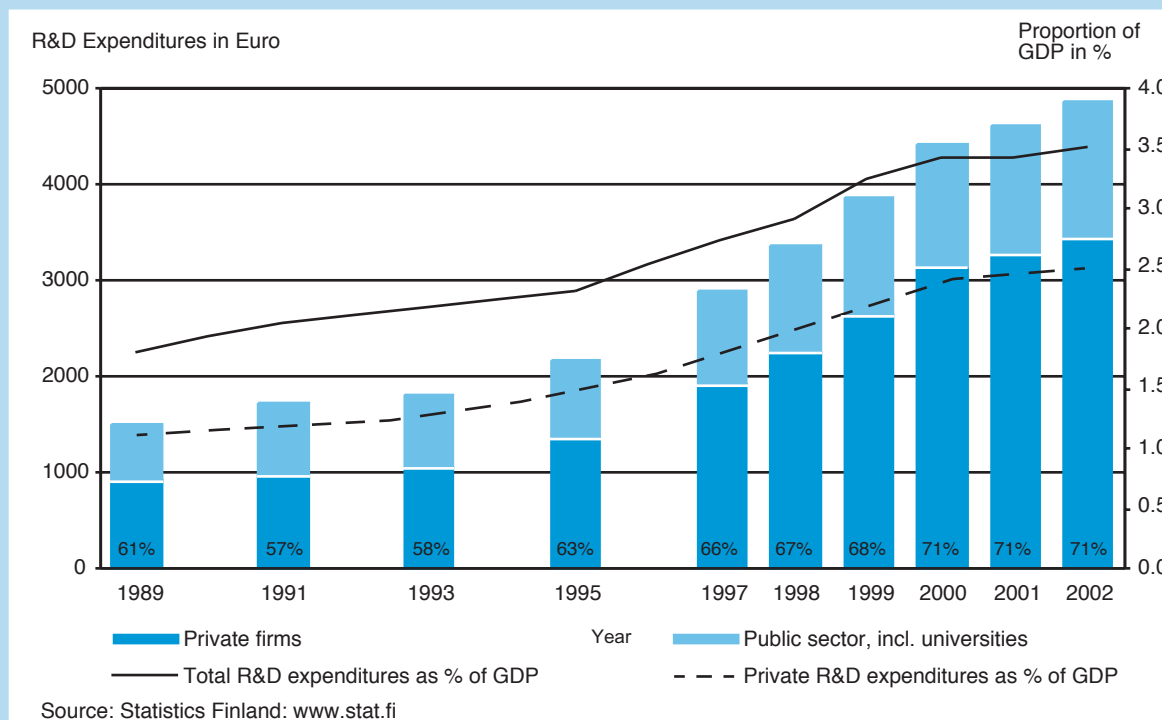
ditures have dropped from approximately 40% in the mid-1990s to just under 30% at the beginning of 2000. This shift in the proportion of private-sector and public R&D spending is due to an *increased commitment of private companies*, and particularly to the strong growth of R&D expenditures by Nokia, which account for the largest proportion. The ratio of public and private R&D expenditures in Finland has therefore come to resemble that of Switzerland, where since the early 1980s private R&D spending has accounted for just over 70% of total R&D expenditures.

As has been mentioned before, it is crucial that the *proportion of researchers in the total workforce* has seen a significant increase. It amounts to just under 23%, which has placed Finland far ahead of any other country in the world as regards the number of R&D workers.

Close cooperation between actors

An important characteristic of the Finnish innovation system — and a significant element of its success — has been the long-standing, close, *excellent cooperation between private and public actors*, with Tekes as a public actor being particularly supportive. Finland as a centralised state has fewer actors than Switzerland and its innovation system has simpler, *clearer structures* stimulating interplay among the various actors, including those in the public realm. Cooperation is particularly evident between public actors in technology programmes, with Tekes cooperating with the Academy of Finland and VTT (see chapter 2.4 for more on these organisations).

Development of R&E Expenditures in Finland (1989-2002)



Higher-quality research

In the 1990s the Academy of Finland – like the Swiss National Science Foundation (NFS) in charge of promoting *basic research* – strongly encouraged the development of research, with a particular emphasis on improving the quality of research. One instrument was to establish *Centres of Excellence*. This programme resembles that of the National Centres of Competence in Research (NCCRs) of the Swiss National Science Foundation in that it develops strong research units that enjoy international prestige. Other measures to improve and maintain the quality of research in Finland have been aimed at human resources. Graduate programmes at Finnish universities have improved. Also, in the late

1990s a wide-ranging post-doctorate system was created. These measures seem to have borne fruit: in its report on the „State and Quality of Scientific Research in Finland“ published in 2000, the Academy asserts that the Finnish system is very competitive and ranks very highly in the international comparison of systems. The strengths of the Finnish system are its competent researchers, and its excellent educational system for researchers.

Systematic use of evaluations

With regard to improved quality of research, the *systematic use of evaluations* and application of their findings must be emphasised. Evaluations provide feedback on the quality and effectiveness of re-

search institutions and research in general, as well as on the impact of technology programmes, policy instruments, and organisations in innovation policy.

Finland has been using evaluations in the fields of research and technology for some twenty years now. They are well-established instruments in the development of the innovation system. Highly advanced methods are used regularly to evaluate programmes, measures and organisations. A true evaluation culture has been established. Individuals and organisations to be evaluated have lost their initial resistance and have come to appreciate the feedback provided. Also part of the evaluation culture is the fact that the vast majority of all evaluations is made public. However, evaluations are not conducted for their own sake alone. *Findings are adopted in the formulation of future policies and strategies.* R&D evaluations have become a well-established instrument in Finnish politics and the public administration.

Internationalisation of the research system

The Finnish research system has become more international since the 1980s, with Finnish researchers increasingly participating in Scandinavian, European and other international research programmes. After *accession to the EU* in 1995, Finland internationalised its research system even further because it was recognised that Finland as a small, open economy depends on knowledge produced abroad. One of the most important objectives of international cooperation therefore is the acquisition of research-based knowledge. Effective cooperation is based on mutually beneficial exchanges, which means that Finland requires its own strong knowledge-base to be an attractive partner.

Universities create human capital and infrastructure

Establishing and expanding the Finnish universities has been one of the most important public contributions towards strengthening the innovation system, an effort that has benefited the big Finnish corporations the most. The human resources and infrastructure of universities and other educational institutions have been improved and expanded to meet the private sector's present and future needs. In recent years, for example, the Helsinki University of Technology and the universities of Tampere, Oulu and Jyväskylä have seen an unprecedented increase in students, experts and facilities in telecommunications and other high-tech areas.

2.4. An Overview of the Finnish Innovation System

Innovations are essentially marketed by private enterprises. In Finland, these enterprises are supported by various organisations in the fields of education, research and politics, which together form Finland's innovation system. This system is presented briefly in the following section (see table below).

The two most important ministries in the Finnish innovation system are the *Ministry of Education* and the *Ministry of Trade and Industry*. In 2003 the former controlled approximately 42% of the public research budget, leaving approximately 35% to the latter. Research is also funded by the Ministry of Social Affairs and Health, and by the Ministry of Agriculture and Forestry.

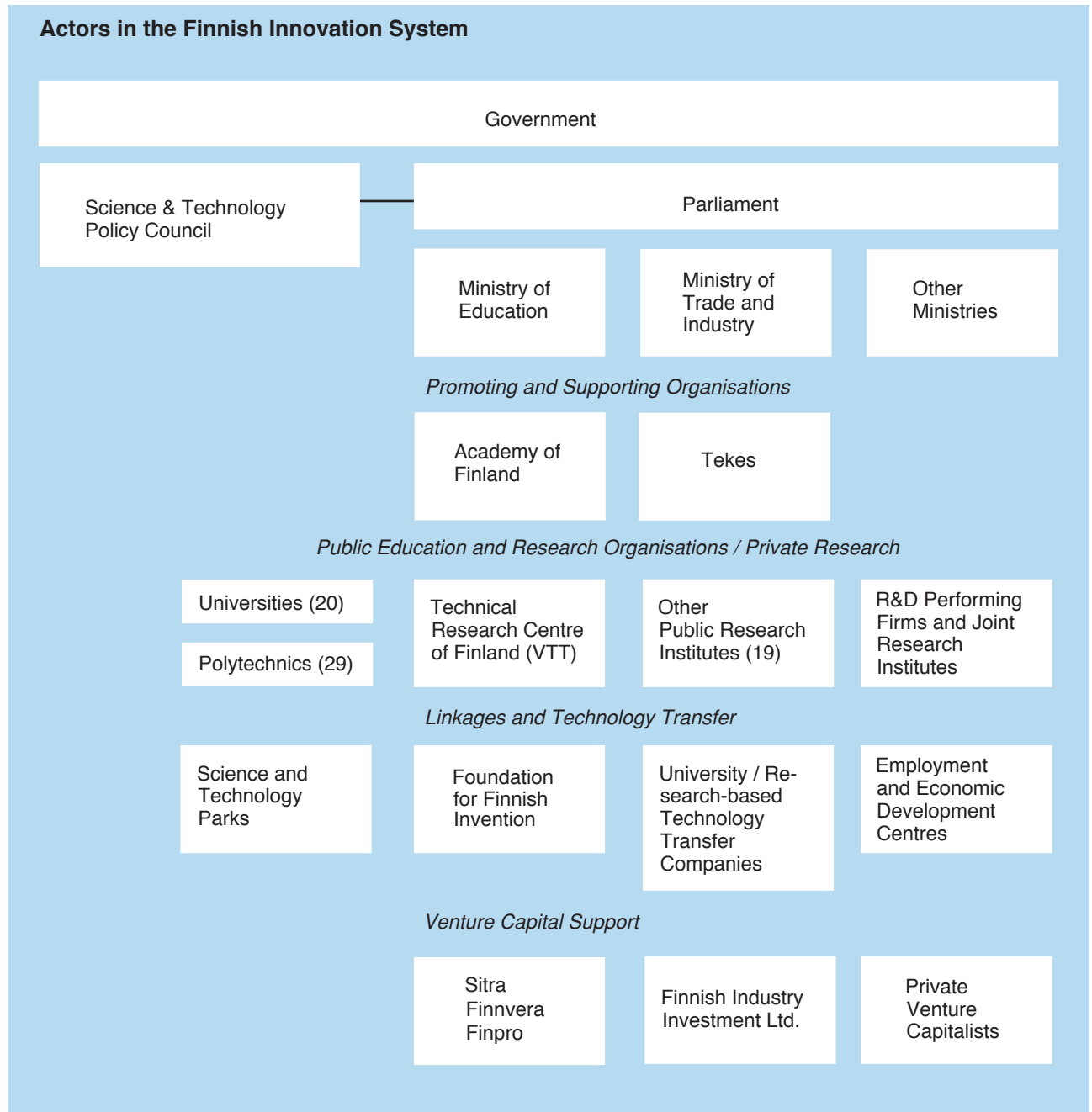
The Ministry of Education oversees Finland's 20 universities, 29 universities of applied science, as well as the *Academy of Finland*. The Academy is the

most important planning and funding instrument in the field of basic research. It fulfils its role by funding individual projects, research programmes, centres of excellence, research posts, and the education of researchers.

The Ministry of Trade and Industry is in charge of formulating innovation policy and of support of private-sector R&D. It is also responsible for EU research promotion, and oversees Tekes, Finland's national technology agency. *Tekes* is the most important planning and funding agency in the field of applied technology research and private-sector R&D. Apportioning approximately 30% of all public research funding, Tekes is one of the — if not the —

most important state organisations in the Finnish innovation system (see also Chapter 3.2.3.).

VTT, Finland's Technical Research Centre, is another important organisation in the administrative field of the Ministry of Trade and Industry. VTT predominantly conducts contracted (applied) research, chiefly entering into bilateral research cooperation with private companies. It is therefore funded not only by public means but also by its contractors. VTT is Scandinavia's biggest public research institution. Finland has another 19 public research institutions, predominantly active in selected fields, such as forestry and the environment (see also Chapter 3.2.2.).



The Science & Technology Policy Council mentioned earlier has assumed a clear, important role in the definition of guidelines, in national coordination of innovation policy, and as a forum of discussion (see box).

Sitra is an independent public foundation supervised by the Finnish parliament. It was created in the late 1960s and assumes an essentially experimental role in the innovation system. The foundation explores future challenges, experimenting with new policy instruments. Accordingly, its fields of activity

The Science & Technology Policy Council

The Science & Technology Policy Council was founded in 1987 to continue the work of the Science Policy Council established in 1963, albeit with a slightly different focus. Its members are high-level decision makers from the worlds of economics and politics: its President is the Finnish Prime Minister. The Minister of Education, the Minister of Trade and Industry, the Minister of Finance and four other ministers, as well as ten renowned individuals from the fields of science and technology are also on the board. The latter are representatives from Tekes and the Academy of Finland, from the private sector, as well as employee and employer organisations. This illustrious body has made the Science & Technology Policy Council a powerful player.

Every three years the Science & Technology Policy Council publishes a report defining the guidelines of Finnish innovation policy. The most recent report dates from 2003 and is entitled “Knowledge, innovation and Internationalisation”. The Science & Technology Policy Council also plays a crucial role in the coordinated development of the Finnish innovation system, working on improved synergies between science, technology and innovation policies as well as other relevant political areas (regional, environmental, energy, etc., policies).

However, perhaps the most important role of the Science & Technology Policy Council is to provide a forum in which government, private sector and university representatives may develop political visions, and come to an agreement on what constitutes a thriving innovation policy. There is general consensus in Finland that knowledge is key to economic growth, employment and the country’s social welfare. The Science & Technology Policy Council has made a very important contribution towards this national consensus.

have changed over time. Sitra now operates primarily in venture capital, followed by research, education and innovation (see also Chapters 3.2.2. and 3.3.4.).

Further organisations are the Finnish Industry Investment Ltd., Finnvera plc, Finpro, the regional Employment and Economic Development Centres — TE-keskus — as well as the Foundation for Finnish Inventions. Finnish Industry Investment Ltd. is a state-owned investment company chiefly active in

the venture capital business. *Finnvera* plc is also state-owned, and provides financial services to Finnish companies active in domestic and foreign markets. *Finpro* supports private companies in their endeavours to internationalise. The Employment and Economic Development Centres, *TE-keskus*, established nationwide in the mid-1990s, offer advice and support tailored to SMEs in particular. They cooperate closely with the regional representatives of Tekes. *The Foundation for Finnish Inventions* promotes inventions and their application in Finland.

3. Selected Areas in the Finnish Innovation System

3.1. The Finnish Educational System

3.1.1. The Finnish school system

Finland's international ranking among the best also applies to the Finnish school system. The OECD's *PISA surveys* have found excellent scholastic performance of Finland's youth aged 15, i.e. after nine years of schooling. Finnish youth did significantly better than their Swiss counterparts in reading and science, and also did very well in the international context. In mathematics both Swiss and Finnish adolescents achieved results in the average international bandwidth.

In Switzerland the cantons are responsible for compulsory education, which is therefore not part of the federal domain of education, research and technology. As this study is concerned with Swiss national innovation policy, the subject of „schools“ is not one of its core issues, and has therefore not been addressed in the recommendations listed in Chapter 4. Nevertheless, it is well worth examining more closely the reasons for the good performance of Finnish youth in the PISA survey. It could be said that there is little in common between students' skills and development and innovative activities in the private sector. However, it needs to be remembered that the *vocational training system* absorbs a great number of adolescents after their obligatory schooling, and that key decisions concerning general education are made well before young people enter the labour market. Finland's good PISA results are in favour of a broad base of well-educated adolescents about to start work or tertiary education. However, as has been said in Chapter 2.2.2., this

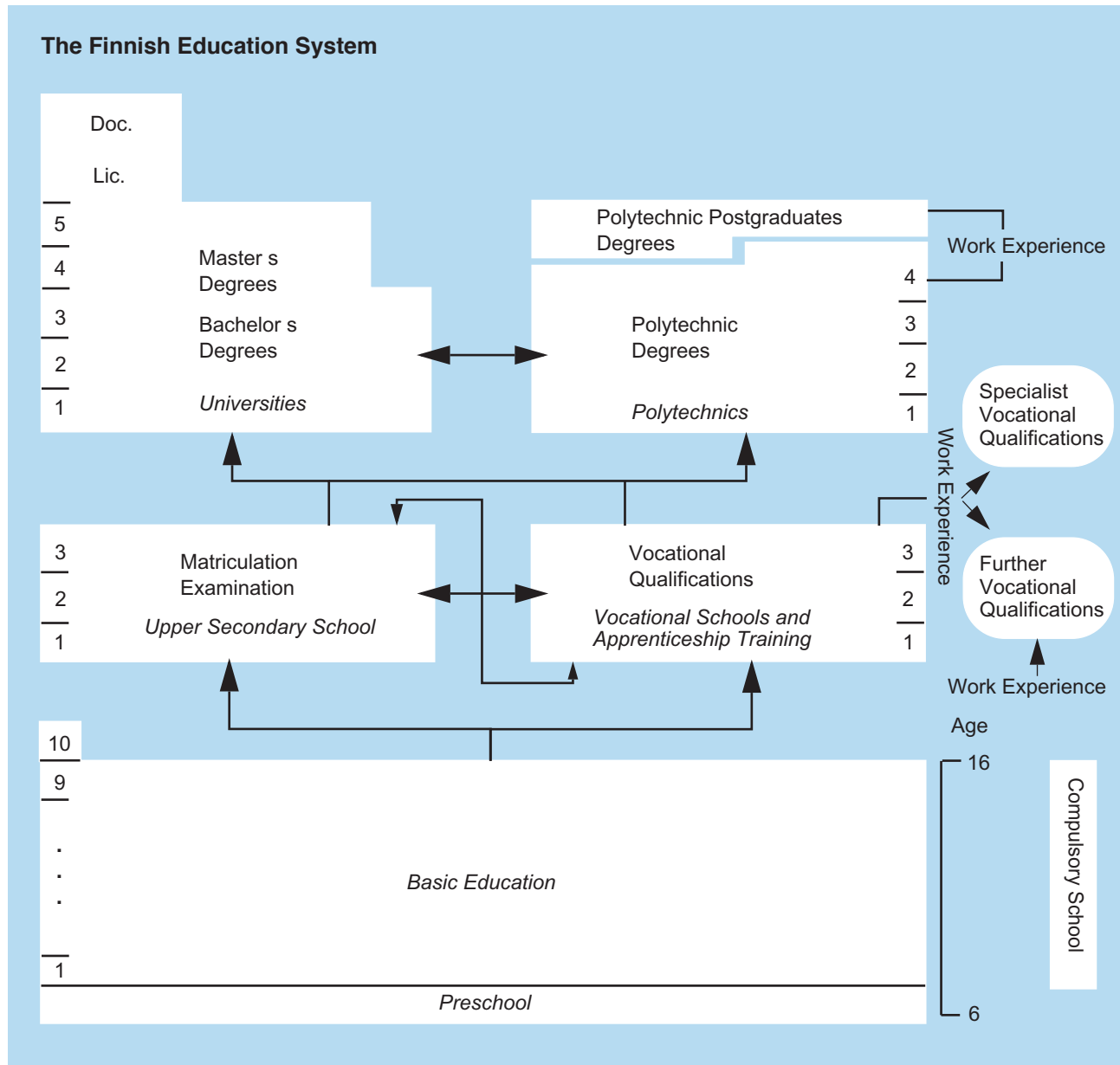
education does not guarantee success in the labour market — at a rate of over 20%, Finland's youth is unemployed at an extremely high rate.

The PISA assessment of students' skills ranked *Switzerland* well behind Finland. Grounds for concern is the fact that a particularly close positive correlation was found in Switzerland between the *social status* of the parents and their children's scholastic skills. In particular, foreign-language adolescents in Switzerland did dramatically less well than their Swiss counterparts. Our Finnish interview partners, however, did not accept the surmise that Finland might have less of an „immigrant problem,“ and fewer difficulties with linguistic minorities. Finland has been dealing with a range of problems involving ethnic minorities from the northern Sámi territory; the country also has Swedish and Russian linguistic minorities.

Finnish experts attribute the reasons for the high performance of Finnish youth to the *strengths of the Finnish school system*. First of all, children remain in the same classroom group from year one to nine. The split between upper-secondary and vocational training only occurs after year nine (see illustration). Finland therefore has a kind of *comprehensive school system*, and children with special physical or mental needs also remain integrated to the greatest possible extent. Team teaching and special teaching modules outside regular classroom hours accommodate special needs. Children from linguistic minorities receive special linguistic support. Moreover, the six-year-olds attend all-day preschool on the premises of their „big“ school to prepare in a playful manner for the challenges awaiting them later. This one-year preschool is *free of charge*, like all

of Finland's elementary, secondary and tertiary education. The *principle of equal educational opportunities for all* is the centrepiece of Finland's educational

policy.



The high scholastic performance is also to be credited to the high standard of Finnish *teacher education*. Children from year one to year six are taught by a form teacher, while the remaining three years are taught by specialists. It needs to be noted that both groups of teachers graduate from university after a five to six-year course of studies. It is rather ironical that the Finns have only begun to fully appreciate this teacher education system and the principle of comprehensive schools, introduced in the 1970s, since the publication of the recent, excellent PISA results.

3.1.2. University education

With regard to *university or tertiary education* the structures in Finland resemble those of Switzerland. Since the late 1990s Finland not only has had 20 universities but also 29 universities of applied science (see also Chapter 3.2.3.). Finland and Switzerland share almost the same experiences and problems with this reform, in that the newly-created universities of applied sciences are very popular with the students. The universities and the world of academe, however, have not yet fully accepted them. Moreover, high-quality R&D has yet to be established at most universities of applied sciences. At the same time, critics wonder how a total of 49 universities can be justified and sustained in a country of just over 5 million inhabitants.

More than 30% of the Finnish population have a tertiary education. This comparatively high number may also be due to the fact that there are no school fees, i.e. *university studies are free of charge*. Finland does have a problem with long-term students because Finnish universities have virtually no temporal or performance-related selection mechanisms. It is remarkable, however, that the introduction of school fees at tertiary level is not currently an issue. It is believed that students might need to

spend more time raising funds for their studies, which would further extend the time they spend at university. Approximately 75% of all secondary and tertiary-level students older than 16 receive scholarships in the form of a mix of subsidies and state-guaranteed loans which cover the cost of living. Hence, the Finnish *system of largely state-funded tertiary education* is considerably more generous than that of Switzerland.

3.1.3. High value of adult education

The Finnish state greatly values *adult education* and continuing vocational education. Finns are entitled to relatively generous state subsidies for their continuing education which, in conjunction with entitlements to educational sabbaticals, accounts for the fact that no other country has a higher participation of the population in continuing education than Finland. More than half the Finnish workforce regularly access continuing education programmes provided by more than a thousand different organisations. Our Finnish interview partners mentioned a certain „exuberant growth“ in programmes and providers. In this context they referred to the typically *Scandinavian problem* of a fairly chaotic market for continuing education programmes. However, so far no plans have been made for the national accreditation or certification of providers of continuing education programmes which might defuse this problem. In its plans to further strengthen adult education, the new government has focused on the opportunity for older Finnish members of the workforce to complete their secondary education.

3.2. The Finnish System of Public Research and Research Funding

3.2.1. Significance of research and transfer of knowledge

One of the key missions of publicly funded research is the *transfer of knowledge and technology* to the private sector, the only way for research to have economic leverage (see also Chapter 3.3). SMEs in particular need contact with universities and research institutions as those who either cannot or are unwilling to afford large R&D departments are often dependent on input from scientists. Knowledge and technology transfer usually occurs not only from public institutions to private firms but is a mutual exchange which also benefits the research institutions. For example, the universities can learn about the latest technological and innovative developments and priorities in the private sector.

The Finnish innovation system *values highly* both research and the transfer of knowledge and technology, as the numerous (semi-)public organisations demonstrate that are active in this field. According to our Finnish interview partners these organisations are particularly useful when it comes to supporting private companies in projects where they lack know-how, or to finance new products or start-up companies.

3.2.2. Organisations of research funding

Funding of Finnish science is based on the dual support system, in that universities and other research institutions receive *public basic funding* as well as targeted public funds distributed by intermediary organisations such as the Academy of Finland and Tekes. Targeted funding is the government's actual *steering instrument*. These funds are used to sup-

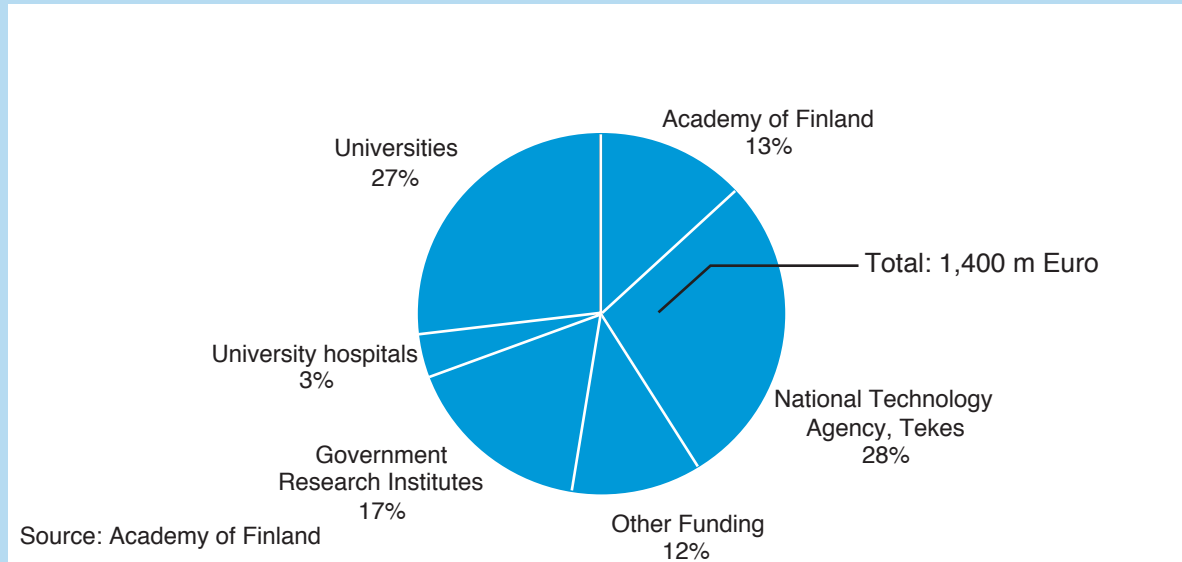
port research projects, research programmes, centres of excellence, as well as educational programmes.

Finland's two most important organisations of research funding are the Academy of Finland and Tekes. While the Academy of Finland finances basic research in all disciplines, Tekes, the Finnish technology agency, is the most important organisation for the funding of applied and private-sector R&D, and for the promotion of knowledge and technology transfer. Another organisation, the Sitra Foundation is a strong player in the field of venture capital, and hence is also deeply committed to knowledge and technology transfer; it also funds research, innovative projects and educational programmes.

The Academy of Finland

The main purpose of the Academy of Finland is funding of *basic research* at universities and other research institutions. The Academy answers to the Ministry of Education, and is funded by the Finnish government. In 2003 the Academy received public moneys amounting to 185 m Euros, over 13% of Finland's total R&D expenditures of 1,400 m Euros (see illustration). However, 28% of all public R&D funding (399 m Euros) went to Tekes and, hence, to application-oriented research. In comparison, in 2002 the Swiss counterpart of the Academy, the Swiss National Science Foundation (SNF), spent over 369 m Swiss francs or approximately 245 m Euros, while the Swiss counterpart to Tekes, the Commission for Technology and Innovation (CTI), received over 80 m Swiss francs, or 55 m Euros. These figures demonstrate that the two countries have different priorities, i.e. Finland spends significantly more of its total public research budget on applied research, while Switzerland gives much higher priority to basic research.

Finnish State Expenditures for R&D, 2003



These figures need to be considered, however, bearing in mind the fact that in 2002 Nokia spent more than twice the amount of the total 2003 Finnish R&D expenditures, i.e. 3,100 million Euros, and employed 19,000 people in R&D.

The Academy of Finland covers all *disciplines*. Similar to the Swiss National Science Foundation (SNF), it has four departments, i.e. culture and society, natural sciences and engineering, biosciences and environment, as well as health. The biggest part of the budget goes to the natural sciences and engineering (33%), followed by the biosciences and environment (25%), culture and society (24%), with health (17%) coming last. Comparing the strength of each category in Switzerland and in Finland, one finds that Switzerland supports the arts and humanities — relatively speaking — less strongly (18%), while the natural sciences and engineering (41%) enjoy more support. In Finland, however, the natural

sciences and engineering also enjoy substantial support from Tekes, although that support is more application-oriented. In absolute terms, however, Switzerland spends higher sums in each category.

The Academy of Finland does not only fund research, it also functions as a *consultant in science policy* and as a *science advocate*. It defines guidelines for science policy, publishes opinions on science-related issues, and drafts plans and proposals for the development of science and research. It also publishes a series of studies on science policy, and manages a substantial library focused on science and technology policies, science and technology studies, as well as tertiary education policy.

Tekes

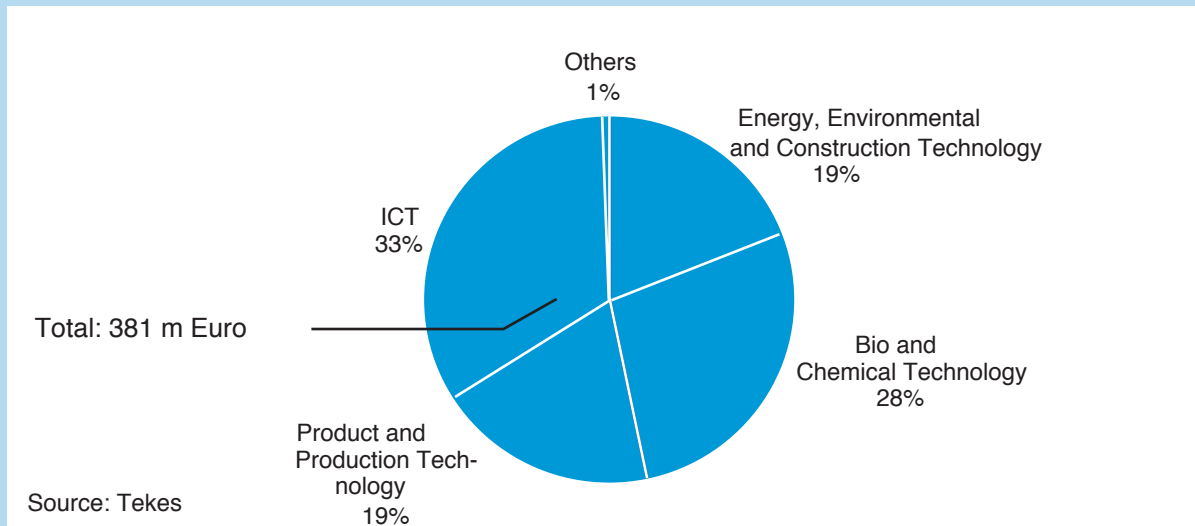
Tekes, the National Technology Agency of Finland, is the most important organisation for the funding of *applied and private-sector R&D*. It provides financial support as well as expert services for R&D projects, and encourages the creation of national and international networks. Tekes is not just a research funding agency but is also deeply committed to knowledge and technology transfer, its chief objective being the promotion of technological competitiveness of the Finnish economy.

Tekes is a key player in the Finnish innovation system. One indication is the fact that Tekes has a seat on the Science & Technology Policy Council. Also, its importance is reflected in its budget. In 2003, the Tekes budget was 399 m Euros, of which about a third went to universities and other research institutions, such as VTT. Two thirds went to private companies, and of these 51% to SMEs. As has been mentioned, the Swiss CTI budget for 2003 amounted to approximately 55 m Euros, seven times less.

In 2002 Tekes funded 2,017 projects, 798 of which were located at universities and other research institutions, while 1,219 came from private companies. CTI funded approximately 400 projects. Tekes provides direct financial support to companies, while CTI only supports partnership projects between research institutions and private companies, with CTI funding going exclusively to the research institutions. Tekes employs 315 people, most of whom work in Helsinki. The Swiss CTI has 24 people in its employ. However, whenever required, CTI can also rely on a large number — a kind of militia — of external experts. It is evident that the two organisations are vastly different, both in their dimension and in their function, which makes it impossible to make direct comparisons.

The *focus* of promotion by Tekes is on ICT (33% of the total budget), as well as bio and chemical technology (28%); other important disciplines are energy, environmental and construction technology (19%), as well as product and production technology (19%) (see illustration).

Tekes Expenditures for R&D by Technological Field, 2002



Similar to the Swiss CTI Tekes pursues two strategies of promotion. On the one hand, the agency only provides funding for *individual* projects by private companies, universities and research institutions based on competitive selection. Project promotion is based on the bottom-up principle, and absorbs approximately 52% of the Tekes funds. On the other hand, Tekes supports *technology programmes* and other activation. Technology programmes are large-scale, network-based R&D activities designed, managed and funded by Tekes. In 2001 some 48% of Tekes funds were awarded to such programmes.

Technology programmes focus on a specific technological area and consist of research programmes at universities, research institutions and private companies. They promote the development of specific technological sectors, and are concerned with the efficient transfer of research results to the companies. Technology programmes are initiated in strategic areas considered essential for the future of

the Finnish economy.

40 technology programmes absorbing approx. 1,300 m Euros were under way in 2003. A programme usually lasts three to five years and requires a sum of six to several hundred million Euros. Every year, some 2,000 companies and 800 research institutions participate. Projects by universities and research institutions commonly receive Tekes funding for 60-80% of their costs, while projects in the private sector receive Tekes funding for 25-50% of their costs.

Tekes technology programmes are geared towards new technologies such as ICT, biotechnology or material sciences, but the refinement of products and processes in the more „traditional“ sectors is also important. The selection, design and launch of a technology programme occurs during consensus-building seminars and workshops with representatives from the private sector, universities and other

research institutions. In that respect, Finnish technology programmes are not prescribed top-down but established in a bottom-up process involving all participants.

Evaluation surveys have found that the chief benefit of the Finnish technology programmes is the close cooperation between research institutions and the private sector. Other benefits concern the comprehensive involvement of SMEs, and international cooperation. In other words, the technology programmes are a powerful instrument of *knowledge and technology transfer* which Tekes has been promoting very actively — and will continue to do so. For example, cooperation and networking are selection criteria for projects enjoying Tekes support. Moreover, all technology programmes have a Tekes-funded programme manager in charge of networking (see also Chapter 3.3.2).

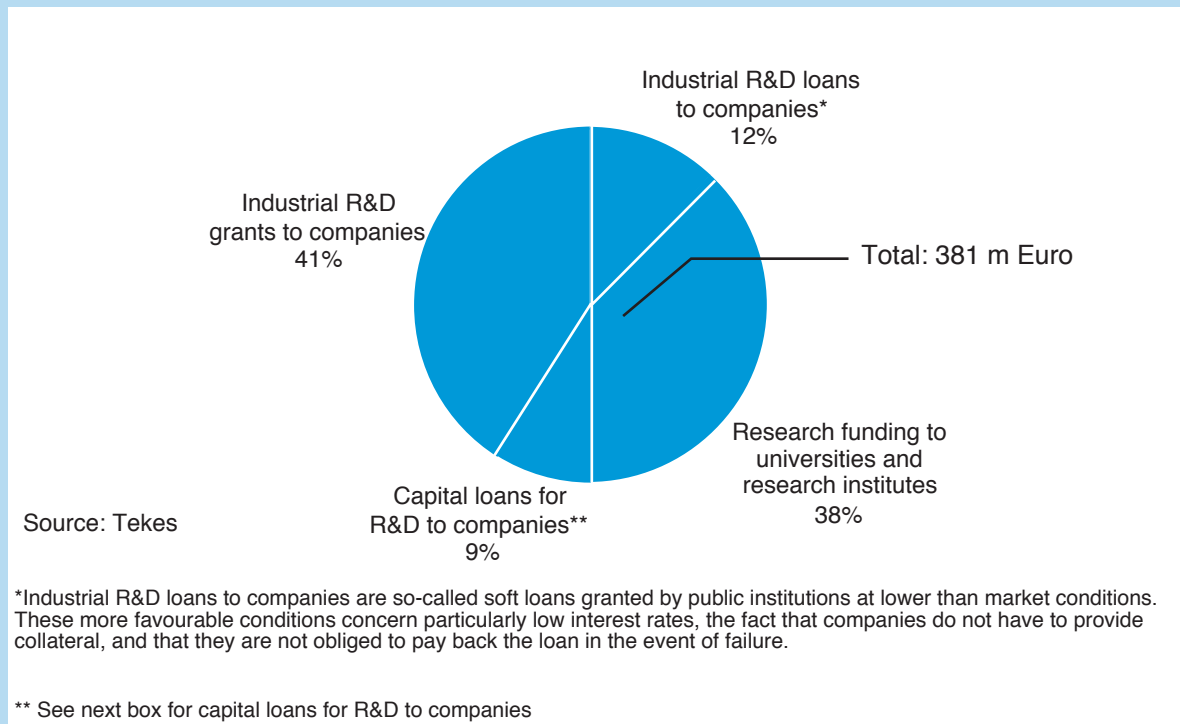
However, Tekes not only requires from its clients to work together, it also practices what it preaches. For example Tekes has been *cooperating* with the *Academy of Finland* for quite some time now. This cooperation occurs at various levels, i.e. among the

directors, or in the context of EU Framework programmes. Moreover, Tekes and the Academy of Finland also jointly fund programmes. Approximately one third of the Academy's current research programmes is co-funded. The programmes are designed and managed jointly, with ultimate responsibility always lying with one or the other of the two organisations. Tekes also has joint programmes with VTT.

Cooperation between Tekes and the Academy of Finland does not seem to be impeded by divergent cultures or approaches. On the contrary, over the past years cooperation and the motivation to cooperate have increased. It is this kind of cooperation that demonstrates the pragmatic approach typical for Finnish innovation policy — it is one of the key factors in the success of the Finnish innovation system.

Tekes not only grants subsidies but loans as well. In 2002 loans amounted to 80 m Euros, or approximately 20% of the Tekes budget. Private companies received subsidies that amounted to twice as much — 157 m Euros (see illustration).

Tekes Expenditures for R&D by Instruments, 2002



Combinations of subsidies and loans are common when a project is close to the market, and its innovative substance is fairly slight. If a project should fail technologically, the loan does not usually have to be repaid. If a project fails commercially, only part of the loan usually has to be repaid. Most loans are, however, repaid (70-80%). The sum of loans having to be written off amounts to approximately 10% of the annual sum of new loans (see box).

Sitra

Sitra, the Finnish National Fund for Research and Development, is a public foundation responsible to

the Finnish Parliament. It was established in 1967 and became active in 1968. Sitra currently has assets of approximately 650 m Euros, and employs approximately 100 persons. Sitra's activities are funded by revenue on the original foundation capital as well as on project investments.

Sitra-funded research focuses on future challenges to the Finnish society at large. Hence Sitra's *research projects* refer to all the substantial issues that concern a highly developed country in the early 21st century. Sitra promotes research that enables decision-makers and the general public to arrive at well-founded economic and sociopolitical decisions.

Tekes' Capital R&D Loans

Capital R&D loans are a more recent instrument intended for the commercialisation of research results. They are intended to help companies close the gap between research, development and market introduction. Capital R&D loans are actually a kind of equity funding targeted at supporting technology-intensive and fast-growing start-up companies and SMEs. The purpose of this instrument is to strengthen new companies' equity. Although they were only introduced in 1997, by 2002 Capital R&D loans already amounted to 58% of all Finnish loans.

According to an evaluation study of 2000 only 9% of the companies that had received this kind of support were threatened by bankruptcy. Had they not received Tekes support, the percentage would have been a great deal higher, i.e. 39%. Moreover, Tekes' capital R&D loans enabled the supported companies to find other sources of equity.

This type of loan only exists in countries whose accounting laws allow for it. After accounting laws changed in Finland in 1997, Tekes introduced capital R&D loans. They are converted into a firm's equity once the project has been completed, meaning that only initially is the loan accounted for as debt. In the event of bankruptcy, capital R&D loans enjoy only a restricted level of protection.

Although loans convert into a firm's equity, Tekes does not become a co-owner. This is where capital R&D loans differ from risk capital. Loans only have to be repaid if the firm turns a profit. In this case repayment of loans takes precedence over the payment of dividends.

Sitra's *educational programmes* have a similar function. They are frequently based on the latest research results, again to assist decision-makers and experts in orienting themselves in an ever-changing world. Courses address key individuals from the public and private sectors, and the media. Finally, with regard to the promotion of *special projects*, Sitra focuses on economic and social innovation, promoting structural reforms in the private sector, society at large as well as in areas where they overlap; it also supports networks.

3.2.3. Research organisations

The universities

As has been mentioned earlier, Finland's approximately 5 million inhabitants have 20 universities, ten of which offer the full range of disciplines and sub-

jects. The other ten are specialised universities — three of them in science and technology, three in economics, and four in the fine arts. Finnish *university policy* from 1980 focused on academic expansion. Between 1985 and 1990 the focus was on improved funding of the universities as well as increased autonomy. Since the 1990s their autonomy has been further expanded, and their services have been improved. Universities play an important role in Finland's regional development. Recent studies have shown that jobs and economic growth have been created in regions with a university, i.e. an institution with scientific and technological impact.

In Finland, a large proportion of basic research is carried out at universities. Under the dual support system they receive basic financing and may apply

for targeted funding from research support organisations. In recent years public funding has become more project-oriented and more competitive. About 60% of research funding at universities comes from the university's own funds, while 40% is from external sources.

Close *networking* between private and public actors has been a great plus in the Finnish innovation system (see Chapter 3.3.2). However, this has not always been so: in the 1970s the universities were not permitted to cooperate with the private sector. The situation changed in the 1980s when cooperation with the private sector was not only tolerated but encouraged. Since then, *research financing* at universities *by the private sector* has increased considerably. This has helped the profile of university research shift towards being more application-oriented. Of all OECD countries, Finland currently ranks highest on the scale of co-operation between universities and the private sector. University research for the private sector and society at large has also received a great deal more attention. However, the economic and social relevance of social and economic research has not been overly impressive so far.

The *engineering sciences* are stronger at Finnish universities than in other European countries. Technological research amounts to 25%, approximately 25% of all university students graduate in engineering. In the late 1990s the predominant position of engineering sciences was further strengthened by the government's decision to promote tertiary-level education in information technology.

Universities of Applied Sciences

The newly-established universities of applied sciences also carry out R&D. They do have, however, quite a lot of *catching up* to do. Applied research done there has not yet reached a very high level.

For example, Tekes only receives few applications from universities of applied sciences, and Tekes funding is rather low. Infrastructure and financial framework conditions are excellent, however, not least due to support from the EU Structural Fund. Salaries are often better than at universities. Another positive aspect is the flexible organisation and management of universities of applied sciences.

The biggest impact of the reform concerning universities of applied sciences has probably been on *regional development*. Spatial proximity enables these universities to be informed of requirements and problems of local SMEs, which are a good field of application for the universities of applied sciences. Even now relationships are good between them, and many teachers come from SMEs. Strong local ties make universities of applied sciences interesting to regional policies. However, it is difficult to say at this stage what contribution they will be able to make to R&D since experience has shown that it is hard to establish one's own potent R&D.

Other research institutions

The biggest and most important of Finland's non-university research institution is VTT (Technical Research Centre of Finland), a multidisciplinary research organisation. It conducts commissioned research for domestic and foreign companies and organisations, and for public authorities. It primarily provides applied technical and techno-economic research. VTT is an integral part of the Finnish innovation system. It plays a key role in the organisation and implementation of national technology programmes, and is an important representative of Finland in EU research programmes (see also Chapter 2.4).

VTT has approximately 3,000 employees, of which some 2,000 are university graduates. VTT therefore

exerts a stabilising influence on the labour market for researchers: when times are bad, the research institution functions as a kind of buffer, employing researchers who have problems finding a job in the private sector. In 2002 VTT had a turnover of 220 m Euros, of which approximately 70 m Euros (31%) was basic government funding, while 150 m Euros was external income; 53% of the external income originated in the private sector; the remaining 47% came from the public sector.

VTT provides research infrastructure for almost all technology-oriented economic sectors in Finland, with the exception of the paper industry. VTT therefore has six research units (VTT electronics, information technology, industrial systems, processes, biotechnology, construction and transport). VTT technology studies is also part of VTT. It is a department concerned with research-related and conceptual issues of innovation and technology policies. VTT *technology studies* does research where technology, the private sector and society at large overlap, analysing innovation programmes and measures, studying trends and changes in technology, conducting evaluations, foresights (identification of important future areas for the private sector, technology, and society at large), as well as technology assessments. Its findings enter into policy decisions.

Alongside VTT there are 19 other research institutions conducting *disciplinary research* in nine different political fields. Depending on the field of activity, the respective research institution answers to a different, thematically related ministry. These institutions do not form a homogeneous group, nor did they develop in the same coordinated manner as the university system. However, these other research institutions play a very important role in the promotion of a knowledge-based society.

Research institutions are an extremely important element in Finnish research. In 2003 they received a total 234 m Euros in public funds, or 17% of public R&D expenditures — more than the Academy of Finland (13%).

3.3. Framework Conditions; Knowledge and Technology Transfer

3.3.1. Framework conditions for innovative companies

Innovative companies are the essence of successful innovation systems and start-up companies are an important source of economic structural change. They provide a lasting boost to an economy's innovation and growth.

Comparisons between countries in the context of the *Global Entrepreneurship Monitoring programme* have shown that framework conditions for Finland's general innovation policy as well as knowledge and technology transfer between universities, research organisations and innovative companies can be considered significantly above average. Further elements are the relatively well-established venture capital market, and the well-endowed support infrastructure by means of a large number of Science Parks in the proximity of universities.

Moreover, empirical studies have shown that, in an international context, the Finns' *entrepreneurial activities* are no more than average. In 2001, just 9.3% of the working population was involved in founding or establishing a company. However, in the international context the Finns are a great deal more optimistic about the potential and range of possibilities, as well as the likely success of founding a company than the rate of new companies would indicate.

The fact that Finland is currently one of the most innovative countries in the world with internationally competitive companies is not least the result of political efforts in various innovation-relevant areas of politics. They have also provided lasting support for framework conditions for innovative companies, such as (1) good cooperation between the public administration and the private sector, (2) excellent infrastructure and high intensity of use in ICT (Internet, mobile communication), as well as (3) the high quality of the Finnish education system and the exceedingly high proportion of highly educated and qualified university graduates — engineering graduates in particular — which explains the high ratio of R&D employees. Moreover, (4) the high percentage of GDP spending on R&D also plays a crucial role.

3.3.2. Cooperation between universities, research organisations and private companies

Finland has a long-standing tradition of *cooperation* between the private sector, the universities and other research organisations, a tradition that has been considerably strengthened since the 1990s. All international benchmark reports rate this interface in Finland as functioning very well, being efficient, and — most importantly — open. It has made a crucial contribution towards Finland's economic success. A good example for cooperation between universities and private companies is the Industry Club of the Optoelectronic Research Centre (ORC) of Tampere University of Technology (see Box).

Cooperation between Universities and Private Companies in the Industry Club

The Industry Club was founded some three years ago by the ORC at Tampere University of Technology. It is a good example of partially institutionalised *knowledge and technology transfer* between the universities and the private sector. Membership to the club provides companies with exclusive access to the university's latest optoelectronics research results. The university's experts can also provide support and consulting on research issues. *Exclusiveness* here means that member companies received detailed information on research results before they are published by the ORC. The ORC is bound to withhold publication for six months if a member has expressed interest in a particular project. Any questions concerning intellectual property are resolved in a subsequent, separate process. The ORC also provides workshops and tours of experiments free of charge, and trains company workers in special fields of optoelectronics. The Industry Club also contributes towards the university's gaining rapid access to private-sector R&D and companies' research needs.

Its infrastructure costing 2.6 m Euros was supported by the EU and other donors. For further expansion in the context of innovative research projects, Tekes has also granted funding (1.1 m Euros). Currently the Industry Club has 12 company members whose annual contributions amount to 10,000 Euros each — adjustable to allow for a company's financial standing. This is a fairly modest sum considering the services provided.

Knowledge and technology transfer is also supported by well-funded promotion of applied research (Tekes). As it is relatively easy in Finland to receive funding for applied and cooperation-oriented research, the number of research projects in this field is very high. Also, approximately 90% of all *master theses in engineering sciences* are written in cooperation with the private industry.

As has been mentioned, Tekes also sets great store by supporting projects involving co-operation or net-working. Moreover, large companies only receive Tekes support if they cooperate with SMEs.

In general, technology-based and innovative companies have good *personal contacts* and relationships to universities. They benefit particularly from research input by universities and other research organisations, by strengthening their technological competence and capacity for innovation. SMEs however, still seem to have to overcome certain obstacles impeding access to universities. Some potential could still be exploited here, for example in the context of *Technology Clinics* (Tekes) (see box).

Finnish Technology Clinics

The Technology Clinic Initiative is a more recent instrument introduced by Tekes, and intended for SMEs. Their main purpose is knowledge and technology transfer from research institutions and universities to SMEs. Technology clinics *support companies' organisation*, management and R&D, and improve their capacity to absorb new technologies and new knowledge. To do so, the SMEs cooperate with Tekes, a clinic coordinator and a technical service provider.

An SME may directly contact a clinic with a problem or a query. The Tekes expert then evaluates the project while the *clinic coordinator* ensures that the project meets the clinic's requirements. The decision on whether or not to accept a commission is taken rapidly and unbureaucratically. When the problem has been analysed the SME receives an offer (including type of service, costs, timetable) by a technical service provider found by Tekes. Examples of typical commissions are feasibility studies potentially leading up to an R&D project, or arriving at an improved test method.

Financial support from Tekes amounts to up to 50% of the costs of a commission; the remainder is paid for by the SME itself. Tekes spends approximately 2 m Euros annually on its technology clinics. 15 to 20 clinics are usually open at any one time; clinics run for two to three years. Tekes decides whether to establish a new technology clinic and to provide it with public funds to buy equipment, etc.

In the meantime, the idea of technology clinics has been adopted by other European countries, Great Britain, for example.

This well-oiled interplay also results in a significant potential in start-up companies and spin-offs from universities and other research institutions. This is particularly true for the creation of spin-off companies resulting from research results and technological developments at universities, usually founded by (former) university employees.

3.3.3. Early creation of science parks in the proximity of universities

So-called science parks were established in the early 1980s in the proximity of universities with the objective of knowledge and technology transfer, in particular to promote start-up companies from the universities, and networking between companies and universities. In these areas Finland has assumed a vanguard function.

Finland generally has an excellent infrastructure. This is also true for the science parks. *The Finnish Science Park Association* (Tekel) comprises 22 science parks with 550 employees in close proximity to university locations, and is represented in all regions of Finland, properly reflecting its objective to enhance regional and locational relevance. The key purpose of science parks is to support marketing of research developed at universities. To do so, new innovative and technology-based companies receive support throughout their pre-founding, founding and early growth stages. Science parks offer education, consulting as well as infrastructure support in various classical areas concerning the creation of a company, assuming tasks and offering services that in other countries fall within the domain of universities.

3.3.4. Well-established venture capital market

Since the early 1980s the venture capital market has become increasingly important in Finland for the financing of risks, in particular of high-tech start-

up companies and the growth of such companies, and is now fairly well established. This becomes clear when the total volume of venture capital is related with GDP. Based on this indicator, Finland, Japan, Sweden and the U.S. are in the top-ranking group internationally.

As a public foundation *Sitra* plays an important role in the financing of risk capital for start-up companies. In the 1980s, with Finland's private venture capital market still in the making, *Sitra* began to create a network of venture capital funds, launching a programme for the systematic acquisition of experience and competence not previously available in Finland. In 1997 the entire venture capital business was reorganised and a process of privatisation initiated; a portion of the public promotion of venture capital business has remained under *Sitra*'s control. These days, *Sitra* specialises in *pre-seed and seed financing*, an area of risks shunned by banks and the capital market. *Sitra* has a team of fifteen professional portfolio managers ensuring the long-term safety of *Sitra*'s public funds. All financing decisions are taken by the board of directors.

According to a recently-published evaluation, *Sitra*'s investments have led to a significant increase in start-up companies in Finland. Also, *Sitra* itself, *Sitra*-controlled venture capital funds, as well as activities shared with Tekes contribute to the fact that of all Scandinavian countries Finland has the highest proportion of seed money of the total venture capital available.

However, the *private venture capital market* has become dominant in Finland also. Insurances (34%) and pension funds (18%) are the most important providers of venture capital, followed by public financing (16%), while the capital market (6%) and banking (5%) are of minor importance.

4. Recommendations for a Swiss Innovation Policy

4.1. Institutional Innovation Policy Framework

In contrast to Finland we do not share a common ground in Switzerland when talking about innovation policy. Finland was the first European country to adopt the term *innovation system* in its governmental and political circles. Finnish decision makers have therefore been able to develop a common notion of factors affecting innovation, and of the political scope available to promote innovation.

Ultimately, a national economy is powered by innovative firms. In Finland firms, science, politics and the administration have combined their efforts and have made innovation their common, high-priority objective. Hence, issues such as education, research and innovation are enjoying the *attention of politicians at the highest level*. The promotion of innovation is being pursued in a *pragmatic manner* right across government departments, offices and regions. This solution-oriented approach of the public sector, which cooperates closely with private firms and academic circles, is a crucial element in Finland's success.

At an institutional level the *Science & Technology Policy Council* reflects this common objective and concept. The Council is a key player in the Finnish innovation system, providing a forum for discussion and consensus. It is where members of the govern-

ment (the Prime Minister and the Minister of Finance, among others), together with top-level exponents from the private sector, social partners, scientists and the administration, develop guidelines on future education, research and technology policy, in short, to innovation policy in general. It is in this council that consensus is forged on the country's future innovation policy, an approach which facilitates homogenous policy-making and coordination with other political issues.

Innovation policy is a modern form of economic policy which is why *innovation research* has gained greatly in significance and political influence worldwide. True competence, however, needs to be able to rely on excellent partners in innovation research. The governments of other countries benefit from *consulting* with competent research institutions. In Finland, for example, there are VTT Technology Studies, Tekes and Sitra with their specialists; in Germany the Institute for Systems and Innovation Research (ISI) of the Fraunhofer Society has a similar function. The Science & Technology Policy Council also relies on expert knowledge. Switzerland, however, has *few specialists* concerned with innovation research and policy. For example, it is only quite recently that the focus has shifted to the relevance of competition in innovation, and of innovation policy as such. Also, Switzerland still lacks a global strategy for a coordinated, national innovation policy.

Recommendation no. 1 Establish an Innovation Council to emphasise and inspire innovation policy at national level

Emulating the Finnish example of the Science & Technology Policy Council, the Swiss Innovation Council will ensure that *innovation policy is placed high up* on the political agenda. Its influential members will be exponents from research circles, the private sector and the public administration. It will create an awareness and common understanding of issues of innovation policy; lend weight to innovation policy; produce public statements; engender strategic decisions; and formulate guidelines for education, research and technology (education, research and technology) to the extent to which the Swiss government is responsible. Inter alia, the Heads of the DHA, DEA and FDF will be part of the Innovation Council. Further members will be the State Secretary or the Directors of federal agencies in charge of education, research and technology. The private sector will be represented by exponents of both large Swiss corporations and SMEs. The heads of the DHA and the DEA will act as Co-Presidents. This composition guarantees a multilateral exchange of ideas and information between Federal Councillors, scientists, exponents from the private sectors and top-level bureaucrats. The Council shall have a maximum of 20 members. For optimum coordination with cantonal governments, representatives of the Swiss Conference of Cantonal Ministers of Education and the Conference of Cantonal Ministers of Economy should be invited in an advisory capacity.

The SATW has long been engaged in the field of innovation policy. Owing to its independence and strong base in research circles and the private sector, it is predestined to initiate the Innovation Council. It will therefore take charge of producing a concept for such a council. The SATW is committed to promoting changes in Swiss innovation policy, and to doing so with speed, not least by presenting the concept to the Federal Council in accordance with relevant government agencies.

The Director of the FDF being a member, issues of financial policy will be taken into consideration from the very beginning. The Competence Centre for Innovation Research proposed in Recommendation no. 2 will be in charge of appropriate scientific guidance. Further experts may also be consulted.

Recommendation no. 2 Establish a Competence Centre for Innovation Research to rationalise innovation policy

Initially funded by the Swiss government, an academic Competence Centre for Innovation Research with international recognition will be established in Switzerland. Its purpose is to *improve the conceptual strengths* of Swiss innovation policy by studying areas of potential conflict/energy in technology, economy and society. This centre should be established in the context of a National Centre of Competence in Research (NFS/NCCR) of the SNF, i.e. of existing academic institutes, with a so-called Leading House and network of research groups. Long-term funding is to be through third parties.

The Competence Centre will produce empirical analyses to achieve professionalisation and rationalisation of the discourse on innovation policy. It will create essential, future-oriented material for political and private-sector decision makers, including evaluations of institutions and political processes. It will function as a kind of radar for important technological and economic developments, potentials of application, as well as barriers and bottlenecks impeding innovation. It will produce strongly innovation-oriented strategic concepts for the private sector and the society at large. It will promote the development and application of instruments for the conception and evaluation of strategic political and economic decisions. In close *cooperation with universities and agencies of innovation promotion*, it will focus on technologies and future issues that are relevant to Switzerland. Moreover, the interplay with the Competence Centre will strengthen the universities' teaching and research efforts in the fields of innovation research and policy; either side will benefit from this exchange.

The Competence Centre will therefore help to strengthen policy-making at the federal and cantonal levels. It will also promote a coherent and consistent innovation policy that takes into account international developments without imitating (!) them. At the same time, through its cooperation with the academic sector, it will underpin the creation of human resources for the increasingly significant field of innovation research on the Swiss labour market. Lastly, it will actively make substantial contributions to *international discourse on innovation research* by being part of relevant committees, not only to represent the interests and concerns of Switzerland with regard to innovation policy, but also to present the specifically Swiss situation. For example, by way of supporting the Innovation Council (see Recommendation no. 1), it will introduce state-of-the-art innovation research into Swiss innovation policy.

4.2. Knowledge and Technology Transfer

The figures for Finland are clear: *applied research* accounts for a markedly higher proportion of research than in Switzerland, both overall and with regard to public support. This is not least due to excellent cooperation between private enterprises and universities. Like CTI, its Swiss counterpart, Tekes is a well-resourced player in applied research, initiating and promotion cooperation projects between the private sector and academic research circles. The Tekes budget, however, is some seven (7) times higher than that of CTI.

Boundaries between basic and applied research are increasingly blurred. Given that innovative processes are not linear, *smooth cooperation* between the public agencies, i.e. the Academy of Finland and Tekes, is a key factor in the success of Finnish innovation policy. Cooperation occurs at various levels. The two agencies launch joint research programmes, which are mutually monitored and funded. Regular policy coordination meetings, etc., between their directors ensure a flow of ideas and information between the two organisations; mutual inspiration of basic and applied research; and a continuous promotion of research projects across the whole range of fields, right up to and including development and market implementation of innovations.

The *creation of enterprises* is an important instrument in knowledge and technology transfer. It is often impeded by lack of seed money, be that the

company's own or from third-parties; high risks often prevent even the private venture-capital market from providing adequate funds. Sitra is an independent public foundation overseen by the Finnish Parliament. It began to develop the Finnish venture-capital market in the 1980s. Along with a number of other activities, Sitra provides venture capital for the (pre-) seed stage of new firms. Its investments are financed by revenues on capital and on venture-capital investments. Sitra receives no further public subsidies or funding.

Tekes, the technology agency, greatly emphasises networking, both with regard to technology programmes – classical instruments of knowledge and technology transfer – and to the promotion of individual projects. Tekes essentially supports – by means of subsidies and loans – network and cooperation-based projects at universities, research institutes and in private firms. Capital R&D loans are granted by Tekes if and when a project has demonstrated market proximity. They are repayable if and when the lender firm turns profitable, and are becoming increasingly important to small new, technology-intensive firms. Firms that have received such loans are significantly less prone to bankruptcy. The loans also make it easier for firms to find other sources of equity. These loans, then, not only improve start-up firms' own capital bases, they also signal to private investors that these firms have staying power. *Signalling* goes beyond the Start-up Label awarded by CTI; it is an active contribution towards the survival of young Finnish firms.

Recommendation no. 3 Strengthen knowledge transfer and the chain of added value in R&D by intensifying cooperation between SNF, CTI and SATW

Emulating the Finnish example of close cooperation between the Academy of Finland and Tekes, the two Swiss agencies, SNF and CTI, will *jointly (in co-management) define and support programmes and Centres of Competence in Research*, thereby facilitating the consistent funding and monitoring of research projects from the research stage to market launch, taking into account the interactive nature of innovative processes. By observing the following principles the management interface between SNF and CTI will become more professional:

- applications too application-oriented for the SNF, but too basic-research-oriented for the CTI will be managed jointly, with the agencies agreeing on which is to provide financing according to its own rules;
- SNF projects suitable for applied research and development will be identified (if so desired actively by the project managers, and in full respect of intellectual property rights); follow-on financing by the CTI is to be guaranteed;
- KTT agencies at universities will be involved in the cooperation between SNF and CTI early on.

Closer cooperation will make better use of the expertise and potential of both agencies with regard to the development of future-oriented technologies and lines of research. The implementation-oriented part of the programmes and Centres of Competence in Research is to be guided explicitly by well-defined, evaluatable targets.

Knowledge transfer between scientific circles and firms will also be intensified — in a coordinated manner — by the so-called *Transferkolleg or Transfer College*, a platform created by the SATW that is based on the principles of technology transfer and collegial networking. The college will multiply the public impact of information concerning new scientific developments and their potential usefulness; it will foster contacts between scientists and firms. Emphasis will be on results from research projects funded by the SNF. The college will also support contacts between scientific circles and the private sector at the pre-project stage by putting at their disposal SATW's unique contact network of scientists and firms. Thirdly, the college will promote exchanges between the various instances and agencies of the fragmented world of Swiss science by providing theme-specific fora. The SATW will actively seek to harmonise all these endeavours with the SNF and CTI.

Recommendation no. 4 Support of start-up firms at the seed-money stage by creating a seed fund (public foundation)

Emulating the model of Sitra, a public foundation financed by the Swiss and cantonal governments will be created. At the seed-money stage the foundation will bridge the risky, financially difficult initial stage of promising start-up projects by investing *risk capital* according to the strictest selection criteria. The foundation will work very closely with CTI in the context of the Start-up Initiative. The participation of private stakeholders may be considered, providing there is sufficient interest; the creation of a public-private foundation would be a viable alternative. *Professional risk management* is to ensure that the foundation will continue to be able to raise funds through return on investment into successful ventures. Essentially, it needs to be noted that the impact of this foundation will largely depend on the financial clout of the foundation, and on the skills and background of its operative management.

Recommendation no. 5 Achieve equality/equivalence of academic and private research by awarding R&D incentives to firms

The CTI will begin to award R&D incentives directly to expanding start-up firms and SMEs that have submitted projects with a high research and innovation potential. The aim is to put private research on a par with academic research. Emulating the approach by Tekes, the Finnish agency, *loans* repayable on success could also be granted. It needs to be noted that public assistance must in no way displace private support. When awarding *R&D incentives* the same rules as in *EU Framework Programmes* must apply. The possibility to grant research funds to private firms will enhance the CTI's competitiveness vis-à-vis EU incentives. In other words, firms will find CTI conditions to be on a par with those of the EU. This is of eminent relevance because, owing to the local connection of firms and research institutes involved in such projects, CTI incentives have the great advantage that research benefits will return to Switzerland. As in these, research partnerships between research institutes and private firms, i.e. the participation of at least one university in the proposed project, remains a key requisite for funding; however, in the CTI scheme of incentives, not only universities but private firms will also be entitled to receiving research funding. In analogy with Tekes, the strengthening of networking ties will be taken into consideration when loans and subsidies are granted, even though no firm or research agency can be forced to participate in a network or networks against their will.

4.3. Evaluation and Quality Control in Education, Research and Technology

The Finnish system with its systematic, methodologically advanced evaluations in education, research and technology, as well as the consistent implementation of their findings in Finnish innovation policy is impressive. In this respect Switzerland can learn from Finland: the *improvement of effectiveness and efficiency* in education, research and technology evaluations should not only involve agencies but programmes, initiatives, disciplines, and the interplay of actors, as well. However, evaluation results, findings and recommendations must not be tucked away in a drawer; lessons must be learnt, results must be implemented, and be integrated in future policies and strategies. Finland has shown the way by publishing evaluations on a regular basis. The Academy of Finland, for example, publishes all its evaluations; Tekes, most of them. Evaluations therefore give early impulses that may have far-reaching effects. Moreover, *transparency* towards the public, with regard to developments and impacts of political measures on education and science is significantly improved.

Examples for the *implementation* of evaluation-based recommendations can be found at the VTT and at Tekes. For example, the technical research centre, VTT, was completely reorganised following an evaluation in 1993; evaluations of Tekes directly affect its management. Moreover, evaluations of technology programmes are geared towards producing answers to strategic questions. Finally, Tekes' Impact Analysis Unit reports directly to the Ministry of Trade and Industry, organising seminars with representatives from various ministries. These seminars help to disseminate further the evaluation results, as well as any information about measures and chan-

ges that may need to be made. It becomes evident that feed-back processes are institutionalised at policy level, in an endeavour to learn from evaluations, and to make necessary adjustments to existing policies (policy learning).

Finland applies greatly advanced evaluation methods which largely correspond to OECD Best Practice evaluation principles. Moreover, local and foreign experts regularly participate in evaluation studies. Hence, more or less standardised evaluation methods are systematically, continuously, and routinely implemented at an advanced level.

The Finnish experience shows that individuals working in evaluated programmes and agencies have lost their initial reservations, and generally integrate evaluation feedback in their work, with beneficial effects. However, a certain „evaluation weariness“ is also to be detected. In Switzerland, the challenge lies in the nurturing of an *evaluation culture* in which the advantages of evaluations become generally available. At the same time, care must be taken to ensure that evaluations are not carried out for their own sake, but to create benefits for the subjects of evaluations.

Both Finland and Switzerland are facing similar problems, i.e. increasing workplace complexity and progressive ageing of the population, which increase the need for life-long learning. The Finnish coalition government therefore has declared *life-long learning* to be a top-priority issue. It subsidises continuing education, for example, in the form of educational sabbaticals. However, the good rankings in this field make no mention of the fact that Finland suffers from the „*Scandinavian problem*“ of a confusing, inefficient market for life-long learning schemes which lacks competition. High state subsidies have led to an exuberant growth in such schemes. Switzerland can draw several lessons from

this, i.e. to be cautious when providing state subsidies for further vocational education; to emphasise individual responsibility for life-long learning; and to observe the need for transparency and fairplay. A suitable approach might be to establish a general

system of accreditation and certification procedures for providers of continuing occupational education through an independent agency.

Recommendation no. 6 Establish a culture of professional evaluation in education, research and technology as part of continuous policy learning

Programmes, projects and organisations throughout education, research and technology will have to be assessed and evaluated to ensure and promote consistently high quality. What is required is an evaluation agency or programme to plan the use of assessments in education, research and technology. Each research programme will have to earmark a certain amount for evaluations, which are increasingly to be carried out not only *ex post*, but also *ex ante* as well as throughout the project. The aim would be to a) anticipate future developments, b) better assess opportunities, risks and the scope for action, and, c) clear away problems. Legal obligations regarding publication of administrative documents will have to be strictly and consistently applied: all evaluations will have to be *published* in full. The Internet provides a suitable, cost-effective platform which will have to be used with greater frequency.

In order to encourage the speedy implementation of evaluation results, *follow-up* procedures will have to be introduced by the commissioning agency, including adequate funding. These follow-ups will ascertain to what extent the recommendations emerging from evaluations have been implemented, whether there have been any improvements, and to what extent they have been integrated into the drafting of policies and strategies. To ensure adequate communication of evaluation results so that they may actually be adopted, the commissioning agencies will need to organise workshops with key players from the political, administrative and academic circles, as well as the private sector.

Evaluations will be accompanied by *international benchmarking* in the fields of education, research and technology as they relate to innovation policy, by making use of international, indicator-based comparisons, such as OECD examinations, and by identifying successful innovation practices (Good Practices) elsewhere. Finland has shown how one can learn from other countries and still implement one's own brand of innovation policy.

Recommendation no. 7 Introduction of a quality-control system for transparency and fair play in continuing occupational education

To create transparency and fair play among the various providers of continuing education/life-long learning, an independent agency — initially funded by the Swiss government — will establish a system of voluntary accreditation and certification procedures for providers of continuing occupational education. It will provide an Internet-based platform with substantial information on providers, programmes and courses available. Quality will be monitored; objective, transparent criteria will apply.

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